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ARTICLES

TOXICITY OF SEVERAL ORGANOPHOSPHORUS INSECTICIDES TO *GAMBUSIA AFFINIS* (BAIRD AND GIRARD) IN LABORATORY TESTS

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The effects of insecticides on natural predators of aquatic mosquito forms are of concern in mosquito control operations. In a transient water situation, such as an irrigated pasture, the effects of insecticides on predators are usually not directly apparent because most predators, even if they survive the insecticide applications, will die later as the area dries out. In other situations such as lake or river margins or rice fields where water stands for long periods, preservation of predators can be of importance when insecticide treatments are necessary to bring mosquito infestation under control.

The surface feeding minnow, *Gambusia affinis* (Baird and Girard) is an efficient predator of mosquito larvae and pupae in situations where dense growths of vegetation or floating debris do not interfere with its movement. Hess and Tarzwell (1942) indicated that when larval populations of mosquitoes increased, the number of *Gambusia* eating them, as well as the number eaten per fish also increased. This relationship was expressed in a formula called the forage ratio. Yet in no case did *Gambusia* give complete control of mosquito larvae.

Local mosquito abatement agencies throughout California have been active in the distribution of this fish as a mosquito control agent since its introduction to the State April 1922, at which time the State Department of Public Health secured the first shipment of fish of this species from Texas and established a hatchery in the lily pond at Sutter's Fort, Sacramento (Lenert, 1923).

Since chemical control operations are sometimes required when larval populations of mosquitoes build up disproportionately to *Gambusia* populations, it is of value to know something of the comparative toxicities of mosquito larvicides to this fish. Insecticides with low toxicity to the fish can frequently bring larval populations to a level that may be held in check by the fish population, allowing the biotic potential of the fish to offset the need for repetitive chemical control.

EXPERIMENTAL. In this study the effects of eight organophosphorus insecticides on *Gambusia* were compared with malathion and parathion, the insecticides most widely used by California mosquito abatement agencies.

The compounds were made up as 1.0 percent weight/volume acetone solutions from technical or purified samples. The 1.0 percent stock solutions were then diluted further with acetone into decreasing concentrations. Dosages corresponding to the 24 hour LC_{90} on fourth instar *Culex quinquefasciatus* Say larvae, determined from laboratory tests, were selected for testing against the fish since these

[1] The author wishes to acknowledge the assistance of Mr. Theodore G. Raley, Manager, Consolidated Mosquito Abatement, and Mr. David L. Ward, Manager, San Joaquin Fish Hatchery, State Department of Fish and Game in making available sources of fish for this study. The assistance of Mr. James H. Bray, Bureau of Vector Control, in carrying out tests is also gratefully acknowledged.

TABLE 1—Organophosphorus insecticide tests on *Gambusia affinis*

Compound	P.P.M.	24 hr. percent mortality	Average mortality
Thimet [a]	0.05	70, 90, 90	83
Guthion [b]	0.05	80, 30, 60	53
Malathion [a]	0.05	30, 50, 40	40
Parathion [a]	0.004	30, 30, 40	33
Trithion [c]	0.2	0, 20, 0	7
Korlan [d]	0.1	10, 0, 0	3
Delnav [e]	0.05	0, 0, 10	3
Dibrom [f]	0.03	0, 0, 10	3
Dylox [b]	0.5	0, 0, 0	0
Hercules 3895G [e]	0.05	0, 0, 0	0

[a] American Cyanamid Co.; [b] Chemagro Corp.; [c] Stauffer Chemical Co.; [d] Dow Chemical Co.; [e] Hercules Powder Co.; [f] California Spray Chemical Co.

concentrations approximate minimal lethal dosages to mosquito larvae in the field.

The tests were conducted by collecting *Gambusia* with a net from an irrigation ditch about seven miles from the laboratory. Netted fish were placed in a ten-gallon milk can containing water from the natural habitat and transported to the laboratory. Fish were also obtained from ponds maintained at the San Joaquin Fish Hatchery at Friant.

At the laboratory, the fish were poured into large, enamel pans and transferred by a tea strainer to one-half gallon, cylindrical, ice cream cartons containing 500 ml. of distilled water. Ten unsexed fish averaging between 2.5 and 3.0 cm. in length, were placed in each carton. Five ml. of the insecticidal solution were then pipetted into the carton. No food was provided during the test period. No mortality occurred in the controls which were run with each batch of treated fish.

During treatment, the fish were held in a constant temperature cabinet at 70 ± 4°-F. for 24 hours. Each concentration was run in triplicate. The results of the tests are presented in Table 1.

These tests indicate that Thimet, Guthion, malathion, and parathion would cause rather high mortality of *Gambusia* at field dosages. High mortality of *Gambusia* associated with Guthion applications has been observed in the field previously, as has the relative low toxicity attributable to field use of Dylox (Lewallen and Brydon, 1958).

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It is hoped that this number of *Mosquito News* will be in the hands of its readers in time for them to take advantage of the following announcement:

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Your National Advisor cordially invites you to attend a Symposium on the subject of Mosquito Control and Wildlife Conservation to be held at the U. S. Department of Interior, Secretary's Conference Room, Washington, D. C., on April 1 and 2, 1959. The program consists of papers outlining the fundamentals of both subjects by outstanding authorities, with ample opportunity for discussion.

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Copies of the program and information regarding hotels may be secured from Robert L. Vannote, National Advisor, Post Office Box E, Morris Plains, New Jersey.

ST. LOUIS ENCEPHALITIS OUTBREAK IN CAMERON COUNTY, TEXAS

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In late July and August of 1957 we were called upon to offer entomological assistance in the investigation and suppression of an outbreak of encephalitis in Cameron County, Texas, three years following a major epidemic of the same disease in the adjacent county of Hidalgo (Chin, *et al.*, 1957). Epidemiologists from the Texas State Department of Health Communicable Disease Division and Epidemic Intelligence Officers, Communicable Disease Center, U. S. Public Health Service, reported a total of 119 clinically diagnosed cases; a majority of those satisfactorily tested serologically were confirmed as St. Louis encephalitis in the Virus and Rickettsial Section, Texas State Department of Health Laboratory.

A total of 15 entomological working days were spent in Cameron County from July 31 to August 16, 1957, in connection with the epidemic. Emphasis was placed on the demonstration of larval breeding sites and adult mosquito concentrations for the benefit of control crews under the supervision of personnel from the Sanitary Engineering Division, Texas State Department of Health, and the collection of adults to be utilized in virus isolation attempts. Particular attention was directed to the Harlingen-San Benito area, in the northern half of the County, where the cases were concentrated. Approximately 75,000 people reside in the affected section.

The elevation of Cameron County ranges from sea level to 60 feet and marked seasonal changes do not occur. The climate is semitropical, with an average January temperature of 60° F., 84° F. in July and an annual mean of 77° F. The average rainfall is 29.55 inches with most of it falling during the spring or fall. The economy is closely associated with highly industrialized, irrigation agriculture. Principal winter products are citrus and vegetables with cotton of primary importance during the summer.

Extremely dry conditions prevailed at the time of the epidemic as little rain fell in July and none in August. Harlingen reported 4.34 inches in April, 2.32 in May, 6.67 in June and .07 in July. During the investigation the cotton crop had matured and was being picked, resulting in irrigation activities being at a minimum. Irrigation was noted in a few localized areas such as nurseries and the fairways of golf courses, providing breeding media for limited numbers of *Psorophora confinnis* and *Aedes sollicitans*.

Culex quinquefasciatus was the prevalent species, being produced in quantity in urban areas in connection with the municipal procurement of water and the disposal of sewage and industrial wastes. Breeding foci included such sites as the settling beds of an unused sewage plant, the effluent from an operating sewage plant, standing water adjacent to a city well and pooled water in storm sewers. In suburban and rural areas, *Culex quinquefasciatus* could be found around most homes inspected, developing in such places as septic tanks or septic tank effluents, and stock watering containers.

The irrigation canals which crisscross the Valley were found to be well maintained and not breeding mosquitoes. However, each of the canals is provided with an adjacent drainage ditch. For the most part, these ditches were clogged with cattails and other emergent vegetation and when provided with seepage irrigation water were breeding *Anopheles quadrimaculatus, Culex erraticus* and *C. coronator*.

Adult mosquitoes for virus studies were collected alive by hand from such daytime retreats as chicken houses and calf sheds, by light traps equipped with bobbinet

bags instead of filling jars, while feeding, and by sweeping vegetation with insect nets.

The total number of adult mosquitoes collected was 1,900. Of this number 1,619 (85.2 percent) were *Culex quinquefasciatus*. The remainder (14.8 percent) was composed of 146 *Anopheles quadrimaculatus*, 60 *Aedes sollicitans*, 52 *Psorophora confinnis*, 12 *Culex erraticus*, 5 *Aedes vexans*, 3 *Culex tarsalis* and 3 *Culex coronator*.

LABORATORY FINDINGS. Mosquitoes collected for virus isolation attempts were pooled according to place of collection, date of collection and species. In preparing the pools of mosquitoes for animal inoculation pre-chilled sterile mortars and pestles were used for grinding the mosquitoes which were then suspended in 20 percent normal egg yolk (from six or seven day-old-chick embryos) in phosphate buffer (pH 7.4–7.6) containing 1,000 units of penicillin and 250 micrograms of streptomycin per milliliter. One milliliter of suspending fluid was used for each 20 to 25 mosquitoes in the pool. After thorough mixing of the suspension, aliquots were sealed under glass and stored in a deep freeze for any future studies indicated. The remaining portion was allowed to stand in the cold for approximately one hour before centrifugation for 15 minutes at 2500 r.p.m. The resulting supernatant was then used for inoculation of white mice by the intracerebral route. Five mice were used for each mosquito pool.

TABLE 1—Mosquitoes collected for virus testing in Cameron County, Texas, August 1957

Species	Number of mosquitoes	Number of pools tested	Number of positive pools (SLE)
Culex quinquefasciatus	1,619	27	8
Anopheles quadrimaculatus	146	4	—
Aedes sollicitans	60	2	—
Psorophora confinnis	52	2	—
Culex erraticus	12	1	—
Aedes vexans	5	0	—
Culex tarsalis	3	0	—
Culex coronator	3	0	—
Totals	1,900	36	8

The *Culex quinquefasciatus* were collected chiefly from chicken houses, sewage plants and storm sewers, while the *Anopheles quadrimaculatus* were almost all found in cattle sheds. The *Aedes* and *Psorophora* were taken in a few areas being irrigated. As many of the mosquitoes contained freshly ingested blood when captured, they were held alive for 24 to 48 hours to allow for digestion of the blood to insure that viral isolates reflected actual infections rather than merely the viremic state of a host animal or animals. The mosquitoes were anesthetized, sealed under glass, frozen and subsequently taken on dry ice to the Austin Laboratory of the Texas State Department of Health for identification and virus isolation attempts.

Subsequent to the epidemic the following mosquitoes were collected in Cameron County for virus isolation attempts: December, 1957, 1,083 *Culex quinquefasciatus;* January, 1958, 682 *Culex quinquefasciatus;* April, 1958, 216 *Culex quinquefasciatus,* 40 *Anopheles quadrimaculatus,* 34 *Aedes vexans,* 3 *Aedes sollicitans,* 1 *Culex tarsalis* and 1 *Culex coronator;* and May, 1958, 563 *Culex quinquefasciatus,* 366 *Anopheles quadrimaculatus,* 76 *Aedes vexans* and 17 *Culex erraticus.*

Inoculated mice were observed daily for signs of encephalitis virus infections. Sick mice were usually sacrificed. Brains

of mice sacrificed and of those found dead were cultured in thioglycolate medium to check for bacterial contamination. Brains of such animals were also passaged to a second group of mice to insure that a virus was present. The sources of viruses so isolated were proved by re-isolation from the original mosquito suspensions.

If all mice inoculated with a given specimen showed no signs of illness by the ninth day, they were sacrificed and their brains used to make a blind passage to another group of mice which was examined for signs of illness for two weeks before the specimen was considered negative for virus. However, no viruses were isolated in any of the second mouse passages.

Eight different pools of *Culex quinquefasciatus* collected the middle of August 1957, yielded virus. One pool was collected from the pens of a pet farm near Harlingen which specialized in birds and chickens. A storm sewer tunnel (plate 1) in Harlingen was the site where six positive pools were collected. The eighth positive pool was collected from a chicken house adjacent to a residence near San Benito. The first attempts to identify these isolated was by the use of serum-virus neutralization tests in mice using antiserum to St. Louis encephalitis (SLE) virus since complement-fixation tests on serums from human cases of encephalitis had shown SLE to be active in the area. Although this serum had the capacity to neutralize 1,000 mouse LD/50's of our laboratory strain of SLE virus, it did not prove to be adequate to identify these viruses. Further studies within one of these viruses showed ten-day-old chick embryos to be susceptible when inoculated via the amni-

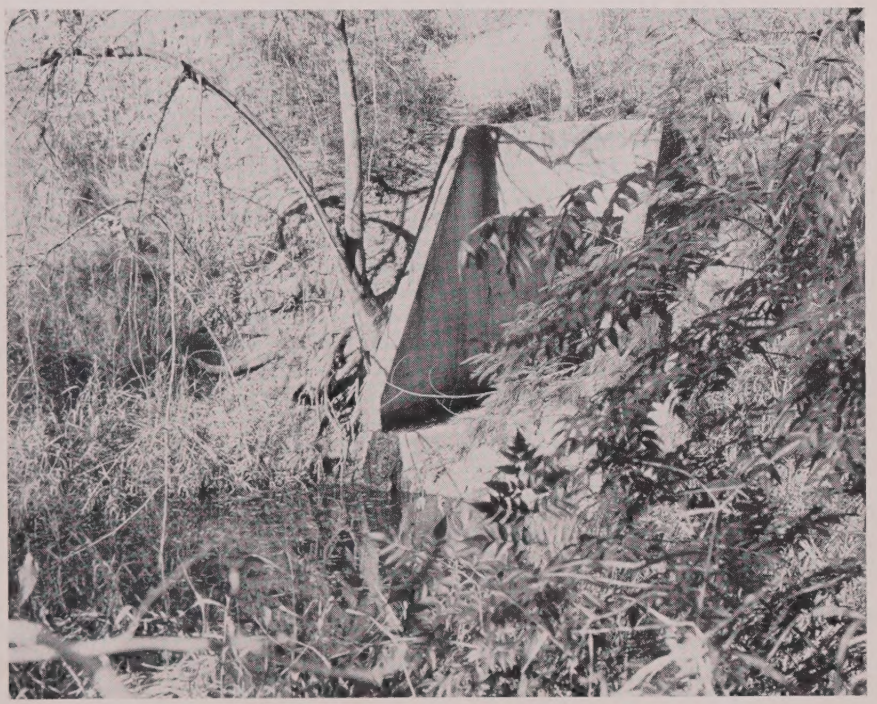

Plate 1.—Storm sewer tunnel in the outskirts of Harlingen, Texas, from which St. Louis encephalitis isolates were obtained from six pools of *Culex quinquefasciatus*

otic cavity. This virus also produced a viremia in one-day-old chicks but it did not kill them.

Continued studies of this one particular isolate were accomplished by the production of antiserum in guinea pigs and mice using live virus vaccine in mouse brain suspensions. Embryo suspensions were used to vaccinate young adult chickens. Antiserum produced in these three types of animals when tested in serum-virus neutralization tests in mice was shown to neutralize the homologous virus and our stock SLE virus but not western equine encephalitis virus. Furthermore the other seven isolates were also neutralized by the mouse antiserum. Finally then it was proved that all eight virus isolates from these mosquitoes were SLE virus.

No viral isolates were obtained from the 3,082 mosquitoes collected from Cameron County in December, 1957, January, April and May, 1958 and processed in 61 pools.

DISCUSSION. *Culex quinquefasciatus* was shown to be the prevalent mosquito during the investigation of the 1957 outbreak of St. Louis encephalitis in Cameron County, as was the case in the adjacent county of Hidalgo during the 1954 epidemic of this disease. Local residents were almost unanimously of the opinion that mosquito populations were low, indicating that sizeable numbers of *C. quinquefasciatus* can be present without being evident to private citizens or even local health officials. Too often, control measures are closely connected with the investigation of complaints —and complaints in the study area usually result from flood water *Aedes* and *Psorophora* attacks. *C. quinquefasciatus,* with its preference for water rich in organic matter, whether in artificial containers, ground pools or slowly moving streams, can develop in abundance independently of rain water.

The frequency with which St. Louis virus isolates have been made from *C. quinquefasciatus,* together with population studies, indicate that the species is an important vector of this disease in the Lower Rio Grande Valley of Texas. Two SLE virus isolates were made in the early fall months during the 1954 epidemic in Hidalgo County (Sullivan, *et al.,* 1957), a single isolate the following January and eight isolates in August during the 1957 outbreak in Cameron County. The findings reported here concerning isolation of SLE virus from *Culex quinquefasciatus* mosquitoes support the belief that *Culex pipiens* complex *(C. pipiens, C. quinquefasciatus* and *C. molestus)* are probably the principal vectors of this virus (Razenhofer, *et al.,* 1957, Beadle, *et al.,* 1957, Hammon, *et al.,* 1945). *Culex tarsalis,* of special concern in western encephalitis transmission, is an uncommon mosquito in the extreme southern portion of Texas. Hammon, *et al.,* (1944) reported only 60 *C. tarsalis* in a total of 22,768 mosquitoes collected in Cameron County in 1942. The species has seldom been taken during more recent studies in the area.

Even with this information concerning the probable vector, the natural history of St. Louis encephalitis in the Rio Grande Valley of Texas is poorly understood. Studies are underway to determine which of the many species of known susceptible birds and mammals abounding in the area are actually of significance as reservoirs of the infection. Serological studies conducted during both the 1954 and 1957 outbreaks revealed that, on the basis of antibody levels, subclinical or inapparent infections greatly outnumbered the clinical cases. During these epidemics such large numbers of people have shown clinical and/or serological evidence of exposure, that the possibility of person to person transmission via *Culex* mosquitoes has been thought worthy of additional investigation.

SUMMARY. During investigations of the St. Louis encephalitis epidemic which occurred in Cameron County, Texas, during August of 1957, a total of 1,900 mosquitoes were collected, 85 percent of which were *Culex quinquefasciatus.* St. Louis encephalitis virus was isolated from eight pools of *Culex quiquefasciatus.* Subse-

quent to the outbreak, 3.082 mosquitoes were collected (December 1957, January, April and May 1958) and processed in 61 pools, with no virus isolates.

Acknowledgments. These investigations were made in cooperation with the Cameron County Health Department, San Benito, Texas. Dr. David M. Cowgill, Director, and Mr. Dudley Johnson, Senior Sanitarian, rendered valuable assistance.

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PREDATION OF DANCE FLIES (DIPTERA: EMPIDIDAE) UPON MOSQUITOES IN ALASKA, WITH ESPECIAL REFERENCE TO SWARMING

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Introduction. The purpose of this paper is to summarize observations of dance fly predators of mosquitoes and to invite attention of the mosquito worker to their interrelated swarming and mating habits. A skimmer dance fly seizes the mosquito during emergence of the latter from the pupa . . . *emergence predation*. I have read no earlier account than Séguy's (1923) succinct: "pendant une éclosion d'adultes de Culicides j'ai vu à Vincennes des Moustiques *(Culex)* non complètement dégagés de l'enveloppe nymphale, dont les téguments étaient encore mous, saisis et dévorés par des *Hilara* qui volent en grand nombre à la surface de l'eau." Unaware of Séguy's observation I reported the same phenomenon for *Aedes punctor* by *Rhamphomyia* sp. as new (Frohne, 1952a). I first participated at this grim and silent tragedy beside a pond in a small clearing near Auke Bay, southeastern Alaska while sweeping everywhere for a female *Rhamphomyia* whose mate was swarming with and preying upon male *Aedes punctor*. Such aerial predation at swarms, sharply distinguished from the aquatic predation at pools, was designated *swarm predation* (Frohne, 1952b). The following year Alexander Hubert (1953) reported another example of emergence predation upon two species of *Aedes* and a *Culiseta* from Montana by a *Rhamphomyia* tentatively identified *R. (Megacyttarus) argenteus* Bigot. The present narration is preliminary and impressionistic, and the dance fly predators, although all are abundant Alaskan insects, are virtually unknown to science.

None of the species of dance flies observed attacking Alaskan mosquitoes are yet designated specifically. I sent the *Rhamphomyia* predators of *Aedes punctor* to Dr. Willis Wirth of the U. S. National

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Museum and received the following comment: "These species are probably new as I cannot identify them with any of Coquillett's or Malloch's Alaskan or arctic species in the Museum collection. There are hundreds of species to be described in this large and difficult genus" (letter, Alan Stone, 1952). Dr. Wirth advised appeal to Mr. G. E. Shewell of the Canadian Department of Agriculture, an empid specialist who has kindly indicated complexes without, however, assigning specific names. A representative comment of his (Shewell letter, 1955) explains: "I am sending you herewith a sort of report on your last shipment of empids. I am afraid that I cannot supply you with a single species name and this is not for want of trying. . . . I hope that eventually I shall be able to give you names for them."

After 1952 I devoted a good many summer evenings near camp in various regions of Alaska observing dance flies swarming, skimming, hunting, or visiting flowers. My understanding of their behavior toward mosquitoes now rests on a broader basis although most of the observations have not concerned mosquitoes. In explaining relationships at joint swarms of the two families there is, of course, risk of inappropriate analogy. I have sought objectivity by accumulating specific details about the mosquito predators as well as by observing the other species which evidently ignore mosquitoes. My difficulties in the exercise of swarm-watching led to a sort of procedure. The observer must have time to repeat observations over and over and at different swarming sites. Each night sample collections of each swarm are put in separate, labeled killing tubes for examination next morning. It is scarcely worth while to accept aid of untrained helpers; swarm-watching is not for dilettantes. However, guests who arrive at swarm time are necessarily enlisted. When an evening must be skipped it may be worth while to give the swarm sites a look and a promise, if one returns before morning. Alaskan flies rarely swarm again at dawn, probably because it is usually too cold, but during the persistent twilight past midnight in June some activity may go on for hours after peak swarming. Weather and detailed estimations of aggregations and rates should precisely specify swarm location and time. General weather and average counts may mislead. The most useful data are repetitive records of individual swarms jotted down on the spot. For the weather it is best to record temperature, cloudiness, wind, rain, etc., when swarming begins and ceases, but this is not always practicable. Good comparative records (June) were made at 20:30 (Alaska Standard Time). More important than efficiency is leisure for revision and rechecking of impressions until a degree of predictability permits satisfactory conclusions.

Different dance flies characterize all sorts of habitats and microhabitats, especially the aquatic ones. For example, after heavy rain in McKinley Park in early July 1954, road rut puddles were coursed over by flotillas, as it were, of a scrounging skimmer *Hilara.* In the spray of vertical, bridal veil falls near Juneau an especially large empid flitted or rested within the splash on the rock wall behind about middle of July. On July 7, 1953 notoriously stormy Naknek Lake was calm and I found it thinly covered by dispersed myriads of an empid skimmer. The lake is forty miles long and several miles wide, yet a trip by outboard motor of over three hours revealed no break in this diffuse, countless host in ceaseless flight two or three feet apart, buzzing and striking at bits of flotsam. Among many such casual observations several additional examples of nexus between dance flies and mosquitoes were brought to light.

Swarm Predators. An Alaskan *Rhamphomyia,* resembling the one first reported preying upon *Aedes punctor* swarms at Auke Bay, attacked males of *Aedes communis* and *cataphylla* observed in 1953 swarming in a glade near Chitina (Copper River valley) Alaska (Frohne, 1954). The dance fly males, which usually greatly outnumbered the mosquito males they were seizing and carrying off, also swarmed on several evenings when no mosquitoes

were seen at the swarm site. A few rare instances of mating of the *Rhamphomyia* at the swarm were spied and the female was then secured *in coitu*. Her wings are distinctively bicolored, partly clear, a condition evident in flight. If mating were the only purpose of the male swarms, the comparative rarity of females puzzled me, as it did in the species at Auke Bay the year before.

Aedes excrucians also swarmed at Chitina (Frohne, 1954). Dance flies ignored the *excrucians* swarms, which are rather spontaneous, large, diffuse aggregations with a loose core constantly moving irregularly about. Now and then the core dissipates and materializes unexpectedly like a djin of the Arabian Nights at another point twenty or thirty feet away. *Excrucians* did not swarm in the secluded glade chosen by the other two *Aedes* but instead over a spacious clearing not far away. Although this larger species has a very different swarming behavior from the furtive, rather persistent, definitely focalized *communis* and *cataphylla,* I thought the erratic swarming habit of *excrucians* might afford the species a certain immunity from attack of glade-swarming dance flies, but the idea did not find support in the following season's observations.

The following June the identical *Rhamphomyia* was observed preying on swarms of *Aedes communis* peculiar to the arctic open-country form of that species occurring in the relatively treeless taiga near timber line in Mt. McKinley National Park, Alaska (Frohne, 1955). The *Rhamphomyia* swarmed here quite in the open but again the cores of its swarms coincided with the cores of *communis* swarms. At times the dance fly males outnumbered the mosquito males and harried individual mosquitoes out of the common swarming site. There were several evenings when no male *communis* swarmed, but their absence did not discourage a large swarm of male *Rhamphomyia* from assembling. That summer excellent visibility conditions and ample time favored corollary observations, which provided some missing facts on the female with the bicolored wings. During lulls at swarms, roaming about searching for additional swarm sites, I found secluded swarms composed almost entirely of this bicolored female. Two such swarms were followed several nights during the last week of June. The sites were similarly sheltered by bushes adjacent to a bluff, situations rather like the glade swarming site of the male at Chitina. Unfortunately visibility was rather poor at female swarms. Predation was not seen but should not be ruled out altogether. No mosquitoes swarmed there. The most notable observation was that mating took place at frequent intervals, indeed, every time a male dance fly entered the swarm a scuffle ensued, and a pair left the swarm. I hoped to see instances of males bringing offerings of prey, especially of male *communis* which would have clarified the status of the male swarm of this *Rhamphomyia,* but no instance was seen. Contrasting activities seen at the two types of swarms, male and female, it appears the female swarm has assumed reproductive responsibility abandoned by the male. The whole question of female predation awaits further observations.

Emergence Predators. In the Katmai National Monument, Alaska Peninsula in 1953 I encountered a *Rhamphomyia* skimmer much like the Auke Bay skimmer of the previous summer. However, the new fly frequents streams rather than stagnant pools or ponds. As far as known it does not molest mosquitoes. Observation of its courtship and mating was nevertheless highly instructive and useful later on. The appropriate female was soon taken flying several feet above the stream while the males seldom left off skimming close over the water. This female is garishly marked with an extensive silvery abdominal "saddle" which flashes conspicuously as she crosses beams of sunlight in her gadding flight. Mating was repeatedly witnessed in broad daylight of mid-afternoon over a sheltered pool in a small, brushy stream at Kukak Bay. Copulation was occurring all afternoon from at least 15:00 to about 18:00 A.S.T., appearing always much the same: the

female flitted down flashing silver (as though taunting the skimming males) several times; a male suddenly would lift from the surface, overtake her, clasp her; they would struggle momentarily, drop a foot or two, and then depart laterally into the alders fringing the pool. Evidently the female does not skim. This observation appears to confirm Hubert's (1953) report from Montana that no females are taken skimming. It is not clear whether or not Hubert saw his species' female but from the circumstances of its suggestive specific name, *argenteus,* it is not unreasonable to suppose there may be a close relationship to the Kukak Bay species. At Auke Bay I had the impression that most of the drab females of that species of *Rhamphomyia* skimmer were otherwise and elsewhere occupied than with skimming, for I caught only a few of them sweeping over the water.

The following season, 1954, I encountered a pool skimmer at McKinley Park which does not differ, as far as I can see, from the Auke Bay pool skimmer. Because of the location of swarms of male *Aedes communis* under observation in a gravelly, triangular wash enclosed by the confluence of Hines and Riley creeks, I followed the development of insects in some old residual oxbow pools in which large larvae of *Aedes pullatus* teemed from mid-June until the Fourth of July. Late in June the *Rhamphomyia* skimmer became abundant and though usually present in the daytime, too, its density increased and it skimmed more excitedly as the evening advanced. It was this build-up which led me to regard the skimming males as a swarm, an idea which is, I think, sound analogy. The peak of emergence for *Aedes pullatus* pupae at these pools came about July 1, and I then watched closely in the hope of discovering *pullatus* mating habits. *Pullatus* pupae are quite wary at emergence and usually seek shelter of the shoreline or a sprig of *Equisetum,* a floating stick, etc., to disclose the adult. The *Rhamphomyia* seized and ate up most of those emerging in the evening, however. I was rewarded one fine, early July night for staying until dark at the area by witnessing the mating of the drab skimmer. It was thanks to previous experience with the Kukak Bay flashy, silvery female that the observation was not missed. As it became almost too dark to distinguish the flies I watched their shadows against the reflection of the sky in the pool and noticed a remarkable difference in their behavior. Skimming tapered off more and more, and flies hovered two or three feet above the water. I guessed this might be a stage in the breakup of the skimming swarm, but I made a special collection and was delighted next morning to find my booty mostly drab females. The following evening I saw quite well this swarm of females from a prone position on my back. Mating was taking place at a high rate until pitch dark, if not longer. Copulation was consummated away from the swarm as usual.

At McKinley Park in July 1954 and 1956 I also collected two species of empid skimmers of ponds belonging to *Hilara.* This is about as far as this observation goes, for neither kind was observed preying on mosquitoes. One of them is characteristic of alpine pools of a kind I have designated type VIII—cold, alpine pools fed by melt of adjacent snow-ice fields, *Caltha* community (Frohne, 1957). It is to be expected that when this alpine *Hilara* is observed at times of emergence of *Aedes pullatus* or *punctor* its predatory habits will implicate it in the biologies of the mosquitoes. *Aedes communis* also breeds in these alpine pools but so early as to anticipate the flight period of the skimmer. The other *Hilara* skims permanent or temporary pools, even of rainwater, at elevations below timber line and is possibly a general predator, but nothing is known of its habits.

DISCUSSION. The observations sketched seemed to indicate that mosquito predation by these empids constituted long-standing adaptations with evolutionary survival value. Predation, swarming and mating are rather mixed up, but they obviously occur regularly, and are not merely occasional, or incidents of exceptional occurrence.

Many more data are needed to interpret the significance of male swarms, especially those in which predation is an added complication. It is to be hoped that mosquito workers will become interested. Some speculations which need testing are: (1) The swarming male empids preying upon a male mosquito swarm are a sexual manifestation quite as much as the mosquito males; (2) Skimmer predators are likewise primarily a sexual swarm and females are as exceptional among skimmers as in other male swarms; (3) Predation is stimulated by presence of prey and light is a less important stimulus; (4) Stimuli for mating are more precise, and proper light conditions are prerequisite. If these impressions are confirmed, male empid swarms may be considered to subserve predation except at certain times when light conditions permit more or less mating. As mating becomes obsolescent in male swarms the female behavior becomes more and more swarm-like. Female swarms seem to be developing to take over the sexual function. In the male, predation has pirated the swarming habit. Evidently female dance flies, like many other Diptera, swarm relatively much less, only when copulation is imminent. The question of securing prey by the females should be investigated, for it is evidently quite different from the corresponding male predation, and is probably an individual enterprise independent of swarming. By analogy light may be shed on nonfunctional male swarms of mosquitoes by study of empid male predatory swarms.

Summary. Two types of empid predation upon Alaskan mosquitoes are distinguished. In one type, exemplified by an uncertain species of *Rhamphomyia* which attacks *Aedes punctor, communis,* and *cataphylla, Rhamphomyia* males swarm in the evening in the identical swarm sites of the male mosquitoes. In a second type illustrated by a different *Rhamphomyia* sp. predation is upon *Aedes punctor, pionips,* and *pullatus* as they emerge from the pupae. This *Rhamphomyia* is a diurnal pond skimmer, but its skimming habit appears to be analogous (in a strict sense *homologous*) with swarming, because mating takes place in connection with skimming, and the species has, apparently, no other type of male swarm. Preliminary observations on similar habits of other Alaskan empids are reported.

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PARATHION-RESISTANT *AEDES NIGROMACULIS* IN CALIFORNIA

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Laboratory investigations on fourth instar larvae of the pasture mosquito, *Aedes nigromaculis* (Ludlow), from an area that had experienced difficulty in achieving control with parathion applications during 1958 showed a relatively high degree of physiological resistance to this compound (Lewallen and Brawley, 1958). On the basis of these preliminary results further investigations appeared to be in order to substantiate the original findings and establish the magnitude of parathion resistance or susceptibility in strains collected from other areas of California.

Mosquito larvae reared in the laboratory under standard conditions are more uniform in response to chemical tests than larvae collected directly from the field. Tests on field collected larvae are sometimes questionable since factors such as variation in nutrition, exposure to agricultural chemicals and transportation fatigue, can markedly influence results. In order to produce *A. nigromaculis* larvae reared under uniform conditions, it was necessary to collect adult females in the field which were capable of supplying fertile eggs. Attemps to colonize this species have failed thus far due to its reluctance to mate in cages.

METHODS AND MATERIALS. *Collecting Procedure.* Strains of susceptible *A. nigromaculis* were obtained from irrigated pastures near Pinedale and Kerman (Fresno County) where insecticides have not been used in a mosquito control program. For comparison, *A. nigromaculis* was collected from the Kings Mosquito Abatement District near Hanford (Kings County) and the Tulare Mosquito Abatement District near Tulare (Tulare County). Organophosphorus compounds have been used in mosquito control programs for the past five to six years in both of these districts.

The same procedures in collecting, handling, rearing, testing, and analyzing the data were observed for all four strains.

Adult females were collected in irrigated pastures, usually during the early morning hours. A mouth aspirator was used to transfer mosquitoes attracted to the collector's bare arms into quart glass jars lined with damp paper toweling. Unfed females were allowed to engorge on the collector's arms before being taken.

Rearing Procedure. At the laboratory, one to three females were placed in shell vials about 3½ inches long by ⅞ inch in diameter lined with a piece of damp paper toweling 3¼ inches long by 1 inch wide. The vials were plugged with a piece of cellucotton. A test tube rack inclined at a 45 degree angle held the vials. Within three to five days, eggs were deposited on the damp toweling.

Dead mosquitoes were removed from the vials, and vials containing newly deposited eggs were placed upright in a gallon glass jar filled to about three inches with sawdust saturated with water. A few phenol crystals were added to the sawdust to prevent development of mold.

The jar was placed in an incubator held at 80° F. for six days to "condition" the eggs. After "conditioning," the paper toweling was removed from the vials, and the eggs washed off into enamel pans 10 inches by 16 inches by 2½ inches deep

[1] The authors wish to acknowledge the cooperation of John H. Brawley and Edward O. Lewis of the Kings Mosquito Abatement District, and David E. Reed and James Whitten of the Tulare Mosquito Abatement District, in carrying out this study. Statistical analyses of the tests were performed by Kenneth Grodavent, Bureau of Vector Control, Berkeley.

containing distilled water filled to a depth of 1½ to 2 inches. Eggs from approximately 10 vials were placed in each pan.

Hatching of the eggs usually occurred within from five minutes to twenty-four hours at about 70° F., the same temperature as maintained for larval rearing and egg deposition.

Larval food consisted of livestock pellets [2] that had been boiled in distilled water for five minutes to kill deleterious organisms; a thick paste resulted. Chunks of paste about the size of a pea were introduced into the larval pans as needed. Air was constantly bubbled through the water while the larvae were developing. Tests with insecticides were performed when the larvae had developed to early fourth instar.

Testing method. Technical or purified samples of insecticides were made up as weight/volume solutions in acetone. Either 1.0 percent or 0.1 percent stock solutions were made, depending on the amount of material available for testing. Aliquots of the stock solutions were diluted further with acetone (usually in tenfold increments) to produce a range of concentrations which killed 5 to 95 percent of the larvae treated within 24 hours.

Individual test units consisted of one hundred ml. of distilled water in a four-ounce paper cup [3] containing 20 fourth instar larvae which had been transferred from the rearing pans by means of a small piece of 16 mesh aluminum screen. Care was taken not to transfer excess water from the rearing pans to the cups. A control was run with each group of treated larvae. Mortality in the controls was consistently nil.

One ml. of the desired concentration of insecticidal solution was pipetted into each test unit, each concentration being replicated three times in each test. Average mortalities were based on three test series giving a total of nine replications for each concentration.

[2] Misco Mills, Bozeman, Montana.
[3] Dixie Cup Company, Anaheim, California.

Treated larvae were held at 70° F. ± 4° for 24 hours and received no food during this interval. Mortality was determined by the criterion that larvae which responded normally when probed were alive; all moribund larvae were included in the dead counts.

Average percent mortalities were plotted on log-probit graph paper as dosage in parts per million vs. percent mortality. A minimum of three points (usually four) was employed in obtaining a straight line which was fitted to the points by eye. LC_{50} and LC_{90} values were determined from the line.

An analysis of variance test was performed on the data obtained on parathion for the four strains studied. There was more variation between the three tests (different collection dates of *A. nigromaculis* females) than within each test (same collection date). This demonstrates the reproducibility of results on material which is reared at the same time. It does not demonstrate, however, whether the discrepancy between successive collections is due to variations which occur in the laboratory or in the field.

Results. The results of tests conducted with parathion against the four strains of *A. nigromaculis* in this study are given in table 1.

TABLE 1—Response of fourth instar *Aedes nigromaculis* to parathion

Strain	LC_{50} in p.p.m.	LC_{90} in p.p.m.
Pinedale	0.000035	0.0001
Kerman	0.00004	0.00009
Tulare	0.00012	0.0025
Hanford	0.00008	0.0068

Since the data for the Pinedale and Kerman strains are in agreement, it is assumed that this represents the normal response of the species to parathion, and consequently the Pinedale strain has served as a reference point in making comparisons with strains suspected of being parathion resistant. In comparison with the susceptible Pinedale strain, the Hanford strain

requires twice as much parathion for a 24 hour mortality of 50 percent and sixty-eight times as much for a 90 percent mortality. The Tulare strain is three times as resistant at the LC_{50} level and twenty-five times as resistant at the LC_{90} level as the susceptible Pinedale strain. This indicates a significant degree of physiological resistance to parathion which undoubtedly is responsible for failures of field applications.

Cross-resistance tests. In view of the high degree of parathion resistance in the two strains investigated, the question of substitute organophosphorus insecticides poses the problem of cross-resistance. To determine the degree of cross-resistance to other organophosphates, limited laboratory tests were conducted observing the same procedures outlined for parathion. The results obtained are presented in table 2.

TABLE 2—Organophosphorus cross-resistance tests with parathion-resistant *Aedes nigromaculis*

Compound	Susceptible Strain (Pinedale) 24 hr.		Resistant Strain (Hanford) 24 hr.	
	LC_{50} in p.p.m.	LC_{90} in p.p.m.	LC_{50} in p.p.m.	LC_{90} in p.p.m.
Korlan	0.01	0.028	0.041	0.058
Malathion	6.01	0.03	0.0058	0.03
Guthion	0.0074	0.01	0.0064	0.01
Trithion	0.015	0.033	0.031	0.052

Graphical analysis indicates cross-resistance in the results obtained with Korlan and Trithion. Field tests with Korlan and Trithion against parathion-resistant *A. nigromaculis* larvae required higher dosages to give complete kill than in areas where parathion resistance did not exist in this species. This evidence lends support to the laboratory findings that cross-resistance to Korlan and Trithion may exist in the parathion-resistant strain.

No cross resistance to Guthion or malathion was indicated in the analysis of laboratory tests. It appears likely that these compounds would successfully control parathion-resistant *A. nigromaculis,* although resistance to these compounds might appear more quickly than in a normal population.

Methyl parathion (Metacide) has been used successfully in controlling parathion-resistant *A. nigromaculis* in field operations carried out by the Kings Mosquito Abatement District.

Further studies on the response of these strains to other insecticides are contemplated.

SUMMARY. A method is described for laboratory rearing of *Aedes nigromaculis* larvae from eggs produced by field collected females. This method was used to obtain uniform larvae for parathion resistance tests since the species has not yet been colonized.

Tests with parathion on fourth instar larvae from two areas that have not been treated with insecticides for mosquito control provided a reference point for comparison with populations presumed resistant to parathion. Tests on larvae from two mosquito abatement districts where parathion has been used in control programs for five to six years indicated that the LC_{50}'s to this compound had increased two to three fold. On the basis of LC_{90} comparisons the larvae from parathion treated areas were 25 and 68 times as resistant to parathion as the susceptible strains.

Cross-resistance tests indicated that parathion-resistant *A. nigromaculis* larvae may also be slightly resistant to Korlan and Trithion but not to malathion or Guthion.

Methyl parathion (Metacide) has been used successfully in field operations to control parathion-resistant *A. nigromaculis.*

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TESTS WITH ESTERS OF CHRYSANTHEMUMIC ACID AGAINST LARVAE OF THE MOSQUITO *CULEX TARSALIS*

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The resistance of the mosquito *Culex tarsalis* Coq. to DDT was first indicated by Smith (1949) in California. During the last few years malathion has been applied as a substitute larvicide in many areas of California, and now resistance has also developed to this compound (Gjullin & Isaak 1957). The search for substitute larvicides has therefore been continued. Particularly promising have been various esters of chrysanthemumic acid (Gjullin & Lewallen 1958).

Thirty-nine esters of chrysanthemumic acid were tested against fourth instar *tarsalis* larvae of a nonresistant strain. A few of these esters were also tested against certain insecticide-resistant strains. Most of them had shown promise as larvicides when subjected to tests against *Anopheles quadrimaculatus* Say by Gahan and coworkers at Orlando, Fla.

Tests for each compound were run in duplicate and replicated twice. The toxicant in acetone was added to 250 ml. of distilled water contained in 400-ml. beakers. The amount of acetone was held constant at 0.08 percent of the water volume. Twenty-five fourth instar larvae were used in each test, and the mortality was recorded after 24 hours. The tests were conducted at 78°–80° F.

Twelve of the esters tested caused mortalities of 95 percent or above at 1 p.p.m. As shown in table 1, the 6–chloropiperonyl and 6–bromopiperonyl esters caused 100 percent kill at 0.05 p.p.m., and were therefore the two most effective larvicides.

Results with the other 27 esters, which

TABLE 1—Percent mortality of fourth instar larvae of a non-resistant strain of *Culex tarsalis* 24 hours after treatment with various esters of chrysanthemumic acid

Ester	1.0 p.p.m.	0.5 p.p.m.	0.1 p.p.m.	0.05 p.p.m.	0.025 p.p.m.
6–Chloropiperonyl	—	—	100	100	97
6–Bromopiperonyl	—	—	100	100	88
Piperonyl	100	100	97	90	78
6–Propenylpiperonyl	100	97	68	23	—
alpha–tert–Butylpiperonyl	100	95	79	17	—
alpha–(1, 1–Dimethylpropyl)	100	96	65	10	—
Allethrin	100	96	37	26	—
alpha–Methylpiperonyl	100	89	22	—	—
o–Chlorobenzyl	98	86	13	—	—
o–Allyloxybenzyl	98	40	16	—	—
3, 4–Dimethylbenzyl	95	95	21	—	—
p–Chlorobenzyl	95	71	37	—	—

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caused less than 95 percent mortality at 1 p.p.m. are shown:

p–Ethylbenzyl	94
2, 3–Dimethoxybenzyl	93
6–Propylpiperonyl	89
Benzyl	87
m–Ethoxybenzyl	86
m–Allyloxybenzyl	86
6–Allylpiperonyl	85
Alpha-Amylpiperonyl	81
m–Methoxybenzyl	80
3, 4–Dichlorobenzyl	74
Alpha–Propylpiperonyl	67
Cuminyl	63
m–Isopropoxybenzyl	62
p–Methoxybenzyl	44
Alpha–(2–methylallyl) piperonyl	19
Alpha–allylpiperonyl	17
1–Piperonylethanol	16
Alpha–ethylpiperonyl	15
Alpha–(p–methylphenyl) piperonyl	9
P–ethoxybenzyl	8
Cinnamyl	8
Alpha–butylpiperonyl	7
3, 4–Methylenedioxyphenethyl	6
3–(3′, 4′–Methylene–diozophenyl) propyl	3
m–Proproxybenzyl	2
4–Hydroxy–4–methyl–2–pentatone	2
Alpha–methyl–p–methoxybenzyl	1

Tests were also conducted to determine the effectiveness of the 6–chloropiperonyl, 6–bromopiperonyl, and piperonyl esters against larvae from malathion-DDT-resistant and DDT-resistant colonies. These tests have already been briefly discussed (Eddy 1958, Eddy *et al.*, 1958).

The resistance of the malathion-DDT colony was about 75 to 100 times to malathion but only about 5 times to DDT whereas the resistance of the DDT colony was several hundredfold. As indicated in table 2, these strains showed only about a twofold resistance to the chrysanthemumic acid esters.

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TABLE 2—Percent mortality of fourth instar larvae of nonresistant and resistant strains of *Culex tarsalis* treated with three esters of chysanthemumic acid

Strain	0.2 p.p.m.	0.1 p.p.m.	0.05 p.p.m.	0.025 p.p.m.	0.01 p.p.m.
		6–Chloropiperonyl			
Nonresistant	—	100	99	90	26
Malathion–DDT–resistant	100	96	86	67	8
DDT–resistant	—	96	90	64	10
		6–Bromopiperonyl			
Nonresistant	—	100	100	79	7
Malathion–DDT–resistant	100	94	85	67	7
DDT–resistant	—	96	90	64	4
		Piperonyl			
Nonresistant	—	87	37	30	0
Malathion–DDT–resistant	89	61	6	1	1
DDT–resistant	—	76	32	2	4

A STUDY OF THE MEDICALLY IMPORTANT MOSQUITOES AT HOLLOMAN AIR FORCE BASE, NEW MEXICO [1]

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Introduction. Holloman Air Force Base is located in an arid valley in the southeastern section of New Mexico at an elevation of approximately 4,090 feet. The base is situated 10 miles from the town of Alamogordo in Otero county.

During the summer of 1958, the entire base area was under constant annoyance from vicious biting mosquitoes. Most seriously affected were the housing areas, golf course, and the aircraft flight line, where persons worked outside after dark.

Not only were the mosquitoes causing a great deal of personal annoyance and secondary infection in some of the bites, but there was a definite possibility of the occurrence of the virus encephalitides. Dr. W. G. Wisecup, Base Veterinarian, stated that there had been recent occurrences of encephalitis reported in New Mexico in both human and horse populations. Identification of larvae and adult mosquitoes collected from various areas on and adjacent to the base demonstrated the presence of *Culex tarsalis*. This species is the classic transmitter of encephalitis in the western United States.

Collection and Identification. Adult mosquitoes were hand collected in chloroform killing tubes from various areas on base, e.g., airmen housing, Wherry housing units, golf course, and the areas of heavy vegetation near the sewage oxidization ponds.

Approximately fifty adult female mosquitoes were mounted on entomological paper tabs and attached to mounting pins. After classifying each of five groups of adults, it was observed that only *Culex tarsalis* was present in the housing areas while those from the outlying vegetated regions were predominantly *Aedes nigromaculis* with a few *Aedes dorsalis*. In order to supplement the hand collections, two New Jersey type light traps were placed in operation for one night and the collections counted and classified. The trap located near the golf course club house accounted for 44 percent male and 46 percent female *Culex tarsalis*, 2 percent male *Aedes nigromaculis*, and 7 percent male along with 1 percent female, of unidentified species. The collections from the trailer court trap showed 35 percent male and 65 percent female *Culex tarsalis*. It was quite evident, from the adult collections, that *Culex tarsalis* was the only species of any consequence causing annoyance in the housing areas at the time of the survey. Barnes, 1955, stated in his paper, "It *(Culex tarsalis)* is active at dusk and makes persistent efforts to enter buildings in search of blood."

A ground and aerial (helicopter) survey of all possible larval development sites on base and surrounding private property was accomplished.

Sod samples were taken from four general areas that would normally become flooded during the rainy season. The sod samples were placed in artificial containers and flooded with tap water. After a period of less than 6 hours, the first instar larvae of *Aedes nigromaculis* were noted in the samples taken from a dry shore line region surrounding the swamp where *Culex tarsalis* larval were in continuous development. No larvae emerged from the other three area samples, including those from the turf strips of the horticultural nursery which receive periodic flood irrigation.

Ecology of the Swamp. A large swamp and slow moving stream with an esti-

[1] This article represents the views of the author and does not necessarily constitute the opinions, ideas, or policies of the United States Air Force (AFR 160–94).

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mated 40 acres of water surface proved to be an ideal habitat for mosquito development. The marsh was created by the overflow from five sewage oxidation lagoons covering 12.7 acres. Approximately 600,000 to 800,000 gallons of sewage effluent flows into the swamp daily. During the wet winter and spring seasons, natural rainfall causes a rise in the water level and subsequent flooding of the dry shore line, which results in emergence of large populations of the floodwater mosquito, *Aedes nigromaculis.*

The predominant species in the entire marsh region was *Culex tarsalis.* The majority of the larvae and pupae were observed among the dense stands of grass in water from about four to eighteen inches deep and in the small open patches of water (one or two square feet) surrounded by green floating algal growth commonly called "green floating swamp moss."

The water from the swamp lake flowed southwest forming a slow moving stream with small side ponds and water-grass patches where there was a great abundance of breeding—up to 40 larvae or more per dip, with an average of 10 to 20 per dip. All of the larvae that were observed and mounted on slides from this area were *Culex tarsalis* with the exception of two specimens of *Culiseta* sp.

In the stream, the water was approximately 6 to 10 inches deep where the larvae were developing. The water was quite clear and cool. Green floating algae covered a large portion of the stream surface and side ponds. The breeding was again taking place in the open patches of water amongst the algae. Some of the larvae were apparently seeking shade during the heat of the day (100 degrees plus or minus 5 degrees F.) by occupying the sheltered areas just under the edge of the patches of floating algae. In places where the water was well shaded by scrub brush, salt cedar (*Tamarix* sp.), sedges (*Carex* spp.), and tall narrow leaf grasses, larvae could be found breeding in water less than 6 inches deep, but in shallow water that lacked sufficient shade no larvae could be found, probably due to the high water temperatures during the day.

In the shallower regions of the swamp lake where the water temperature was a few degrees higher and the water more stagnant, a few unidentified species of *Aedes* and *Culex* were collected that were not observed in the main breeding areas.

In all parts of the swamp and stream, extremely large populations of rat-tailed maggots (*Tubifera* sp.) and other sewage breeding Diptera were found developing. The presence of these larvae was indicative of the large amount of contamination and organic material suspended in the water and settling-out on the bottom.

No fish were seen in the swamp or stream. The bird population of the vegetative belt in and around the marsh was very small.

DISCUSSION AND SUMMARY. According to the Otero County Agricultural Agent, the towns near Holloman Air Force Base generally do not have a mosquito problem which suggested that the mosquito problem was indigenous to the base area. This theory was confirmed by the fact that the flight range of *Culex tarsalis* is usually less than 2.5 miles (Barnes, 1955) and the nearest town, Alamogordo, is 10 miles away. This was further supported by the fact that the entire region around the base and town of Alamogordo is very dry and covered with sagebrush, with the exception of the sewage swamp, cattle-watering reservoirs and limited irrigation sites. Mosquito breeding could not be demonstrated at the latter two sites.

The floodwater mosquito, *Aedes nigromaculis,* hatches and develops in the water along the flooded shore lines and temporary rainwater pools which occur during the wet winter and spring. Having a much longer flight range (in excess of 10 miles), the floodwater mosquitoes not only cause a lot of annoyance to personnel on the military base, but also migrate on a southwest wind into Alamogordo.

Because of the hardpan layer just below the surface of the soil, which does not allow

the water to percolate through the upper ground layers, drainage of the swamp was considered impractical.

Biological control by introducing minnows into the swamp and stream was not feasible because of the low oxygen content resulting from the huge amount of decaying organic matter in the water.

Successful mosquito control was obtained through the application of insecticides. Malathion was applied both as an adulticide and larvicide by ground fogging and aerial spraying.

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RESIDUAL EFFECTIVENESS OF THREE CHRYSANTHEMUMATES AND TWO ORGANOPHOSPHORUS COMPOUNDS AGAINST MOSQUITOES

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Laboratory tests comparing the durability of residues of six organophosphorus compounds and DDT against adults of a nonresistant colony of *Anopheles quadrimaculatus* Say have been reported in a previous paper (LaBrecque *et al.* 1958). The results obtained with five additional compounds—three esters of chrysanthemumic acid prepared by chemists in the Entomology Research Division and two commercial organophosphorus compounds —are given in this paper. DDT was used as a standard.

Acetone solutions of the compounds were sprayed on plywood panels at 100 mg. of insecticide per square foot. At intervals after treatment approximately 50 *quadrimaculatus* adults were exposed on the treated surfaces under half-sections of Petri dishes for periods ranging from 5 to 120 minutes. The full range of exposures was not used each time, but an effort was made to achieve a range of mortalities that reached or approached 100 percent. After each exposure the insects were transferred to untreated screen holding cages, furnished cotton that had been saturated with a 10 percent sugar solution, and held for 24-hour mortality counts. Results of these tests appear in table 1.

The 2, 4–dimethylbenzyl chrysanthemumate was the most effective compound for 60 days, but lost its toxicity after 90 days. It had a very rapid action as a fresh treatment. Most of the mosquitoes were down when they were removed from the panels after the 5-minute exposures and were so severely paralyzed they could make no coordinated movements. The 2–chloroethyl 2, 2–dichlorovinyl ethyl phosphate was also highly effective for 30 days, but then lost its toxicity rapidly. Throughout the first 2 weeks this compound caused 100 percent mortality in 24 hours after exposures as short as 5 to 15 minutes, whereas 60 to 120 minutes were needed to obtain similar results with DDT. Barthrin was about equal to DDT for 14 to 30 days but inferior afterwards. The 6–bromopiperonyl ester was the poor-

[1] P. H. Adcock assisted in carrying out these tests.

est of the chrysanthemumic acid esters throughout the tests, and *O, O*–dimethyl *S*–(4–oxo–3*H*–1, 2, 3–benzotriazine–3–methyl) phosphorodithioate (Guthion) was ineffective the day after application. The DDT standard had the greatest durability and was the most effective treatment after 90 days. The check mortality ranged between 0 percent and 10 percent.

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LABRECQUE, G. C., GAHAN, J. B. and ADCOCK, P. H. 1958. Residual effectiveness of six organophosphorus compounds against *Anopheles quadrimaculatus* Say. Mosquito News 18(2):94–5.

TABLE 1—Mortality of *Anopheles quadrimaculatus* after exposure to residues of insecticides aged for various periods

Insecticide	Exposure (Minutes)	Percent mortality on residue aged— 1 day	7 days	14 days	30 days	60 days	90 days
		First Series					
2, 4–Dimethylbenzyl chrysanthemumate	5	98	100	100	81	27	—
	15	100	100	100	74	63	0
	30	—	—	—	100	95	8
	60	—	—	—	—	100	2
	120	—	—	—	—	—	12
Barthrin (6–chloropiperonyl chrysanthemumate)	5	17	4	10	9	14	—
	15	80	89	93	38	26	—
	30	100	98	100	94	44	0
	60	—	100	100	91	91	0
	120	—	—	—	—	96	0
6–Bromopiperonyl chrysanthemumate	5	5	—	—	—	—	—
	15	21	14	6	9	6	—
	30	51	61	94	16	17	—
	60	98	97	100	58	53	0
	120	100	100	100	97	81	6
DDT	5	2	0	54	24	4	—
	15	70	93	93	26	63	27
	30	97	100	100	63	71	—
	60	100	100	100	98	97	100
	120	—	—	—	—	100	100
		Second Series					
2–Chloroethyl 2,2–dichlorovinyl ethyl phosphate	5	100	100	74	0	—	—
	15	100	100	100	17	0	—
	30	100	100	100	100	0	—
	60	100	—	—	—	2	2
	120	—	—	—	—	66	0
O, O–Dimethyl *S*–(4–oxo–3*H*–1,2,3–benzotriazine–3–methyl) phosphorodithioate	60	5	—	—	—	—	—
	120	4	—	—	—	—	—
DDT	5	2	—	—	—	—	—
	15	19	30	11	24	4	—
	30	58	50	67	79	57	37
	60	100	97	100	88	100	69
	120	—	97	100	—	100	100

THE ROLE OF *MOCHLONYX CINCTIPES* (COQUILLETT) IN THE REDUCTION OF WOODLAND POOL MOSQUITOES IN OHIO (DIPTERA: CULICIDAE) [1]

CHARLES T. O'CONNOR, Jr.

The larvae of *Mochlonyx cinctipes* (Coquillett) are predaceous on mosquito larvae as well as other forms of aquatic life in semi-permanent woodland pools, and the adults do not bite man. In these respects the species may be classed as a beneficial insect. Matheson (1944) writes that the larvae of this species are frequently very abundant in the spring in woodland pools where they are very destructive to mosquito larvae. Cook (1956) believes that the members of the sub-family Chaoborinae, to which *M. cinctipes* belongs, exert considerable control on the numbers of biting species of mosquitoes. He adds that although the actual extent of this natural control has not been investigated thoroughly, his personal observations indicate that the predaceous larvae destroy large numbers of mosquito larvae. James (1957), in his study of *Mochlonyx velutinus* (Ruthe), concluded that it is not a significant predator of biting mosquitoes in the vicinity of Chatterton, Ontario.

During the course of observations conducted on the life history of *M. cinctipes*, a study was made of the economic importance of this species with regard to mosquito reduction in semi-permanent woodland pools in Ohio.

In laboratory feeding tests, third and fourth instar *Mochlonyx* larvae, which were maintained in three-inch shell vials, consumed three to four first and second instar *Aedes aegypti* larvae per day. One particularly voracious specimen disposed of five of these larvae in six minutes. Twinn (1931) obtained comparable results. He found that four *M. cinctipes* larvae ate 46 *Aedes vexans* larvae in nine days. These observations only reveal the biological control potential under experimental conditions. Under natural conditions, the diverse sources of available food tend to reduce such spectacular results.

Hintz (1951) lists ecological situations in order of mosquito production as: (1) floodwater remnants, (2) artificial containers, (3) woodland pools, (4) swamp ponds, and (5) streams and ditches. He adds that this is roughly in reverse order to the abundance of predators. Mead (1949) states that the worst pest species in central Ohio are temporary pool breeders. In semi-permanent pools where *M. cinctipes* is found there are two factors other than predators which limit the size of mosquito populations: (1) Many members of the pool fauna compete with mosquito larvae for available food. Weed (1924), in his study of a pond, felt that cladocerans completely prevented mosquito breeding by utilizing all of the food. (2) Larger animals create an unfavorable environment for mosquito larvae by their movements. Hintz (1951) states that constant escape reactions by larvae and pupae can slow down their development and expose them to predation.

During the study of the immature stages of *M. cinctipes*, it was found that although large quantities of first and second instar *A. aegypti* larvae were consumed in the laboratory, several factors served to mitigate predation in the field. The relative size of the prey is very important. The eggs of *M. cinctipes* hatch at about the same time as those of the pest species in the woodland pools. First instar larvae of biting mosquitoes were dipped from the pools when *M. cinctipes* first emerged. The larvae of *Aedes stimulans*, the most

[1] This work was done while the author was employed as a research assistant in the Department of Entomology at the Ohio Agricultural Experiment Station.

numerous biting species found in the pools, exhibits a greater mean length in each instar than those of the predaceous species. This intrinsic difference in length and the fact that the immature biting mosquitoes develop more rapidly than those of *M. cinctipes* tend to inhibit predatory action. A low degree of predation may occur in the case of large *Mochlonyx* larvae and small pest larvae, since the range of larval lengths is extensive.

The feeding habits of the larvae are another factor which mitigates their value as biological control agents. The crop contents of 80 third and fourth instar *Mochlonyx* larvae which were killed immediately after collection, were placed on slides for examination. Remains of biting mosquito larvae were found in the crop contents of only two larvae. Both mature and immature copepods and ostracods predominated.

The sparse distribution of *M. cinctipes* is another factor which limits its value in the control of biting mosquitoes. There are relatively few situations in Ohio which provide the semi-permanent pools necessary for the completion of the long life cycle of this species. On the other hand, the most important pest species in this state breed in temporary pools.

For the reasons discussed in the previous paragraphs, *Mochlonyx cinctipes* is not considered a significant predator of biting mosquitoes in Ohio.

SUMMARY. A study was made of the economic importance of *Mochlonyx cinctipes* (Coquillett) with regard to mosquito reduction in semi-permanent woodland pools in Ohio. It was found that, although *Mochlonyx* larvae consume many biting mosquito larvae in the laboratory, their omnivorous habit, sparse distribution, and long life cycle make them economically unimportant in the control of pest mosquitoes under field conditions.

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The District was created under state law adopted in 1927 by the General Assembly of Illinois. The District has functioned for thirty years.

MOSQUITO CONTROL IN ILLINOIS [1]

A. J. BOULAHANIS, P.E.

Under the Federal Swamp Land Act of 1850, a vast transfer of lands was made—first from the Federal Government to the State of Illinois, next from the state to the counties, and later to private corporations and citizens. Proceeds from these sales were used by the state for the construction of early drainage works in order to facilitate the reclamation of these lands for agricultural purposes. By 1879, drainage had become so common that laws regulating its application were badly needed. For the benefit of all, the organization of individual drainage districts became a legal reality during this year. By 1880, several hundred tile factories were operating in Illinois trying to meet the demand for great quantities of drainage pipe. By 1889 other pressing solutions of drainage problems were required because of the rapid municipal development. Out of this necessity, the state passed another significant drainage law which permitted the creation of sanitary districts. By the end of the 19th century, drainage activity within Illinois had gained full stature and had grown to an impressive size, resulting in the reclamation of millions of acres of marshland.

Pestilential marshes gave way to prosperous agricultural land and urban development. The byproduct of this activity was the sharp downward trend in malaria and other mosquito-borne diseases. However, the increased drainage activity, and especially the lowering of the water table by drainage without regard to all phases of mosquito biology created new mosquito problems. Thus the permanent water breeder problem was replaced with the floodwater type. This new twentieth century problem was largely man-made. Flooded situations of a temporary nature developed at a fast pace, mainly due to poor engineering practices such as construction of highways, railroads, drainage systems, and sub-divisions of urban areas without provisions for residual drainage. Likewise, polluted streams and ditches developed rapidly as the problem of economical disposal of raw sewage and industrial wastes increased.

Under these conditions the mosquito problem drew metropolitan attention. A few outstanding civic groups were organized to seek some sort of relief. In 1921, Colonel Otto McFeely, editor of *Oak Leaves,* a newspaper in Oak Park, Illinois, launched a campaign to obtain assistance. During this year he appealed to the Sanitary District of Chicago for assistance in regard to drainage and stream pollution. This plea was heard and the Sanitary District commenced a limited mosquito control program aimed primarily at the reduction of mosquito sources. This program consisted of larviciding and drainage work which was conducted along the Des Plaines River and in the northern part of Cook County where the Skokie marshes were located. As a result of court decisions, however, the work was terminated in 1924.

In 1925, at the request of the Gorgas Memorial Institute of Tropical and Preventive Medicine, Mr. Joseph A. LePrince, then dean of mosquito fighters, came to Chicago and surveyed the entire metropolitan area. His conclusions were summed up in one statement: "The prevailing problem is mostly man-made."

It was noteworthy that the communities recognized that they had created the mosquito problem and that they understood that community effort would be required for its solution. As a consequence, a few months later the Anti-Mosquito Board of Metropolitan Chicago was formed with the Gorgas Memorial Institute coordinat-

[1] A condensation of a longer paper of the same title, which was adjudged one of the two Prize Papers of the Year 1958 by the Western Society of Engineers. The original paper included maps and statistics not presented in this abridgment.

ing all mosquito-fighting organizations in the area. Initial funds were provided by the Cook County Board, and the balance was raised by grants and public subscriptions from various municipalities and individuals. The services of Mr. Edwin M. Skinner, Director of Mosquito Control, were secured and the entire metropolitan program was organized in such a manner that any city or town was granted membership in the Anti-Mosquito Board upon its own application.

Unfortunately, the prevailing mosquito problem was not simple. The solution required sustained funds and professional effort. Furthermore, the area under consideration was larger than was anticipated, and the mosquito control activities that were performed under the Anti-Mosquito Control Board were limited in nature and extent. Nevertheless, these activities had a profound effect on the future of organized mosquito control in Illinois.

By 1927 many people in the metropolitan areas of Illinois had gained through practical experience and public education, a fair knowledge of the prevailing mosquito problem and were highly in favor of combating the nuisance on a community basis with dependable funds. Thus the stage was set for mosquito abatement enabling legislation on a state-wide basis, and on July 7, 1927, the General Assembly of the State of Illinois passed a law permitting the creation of mosquito abatement districts. This law was barely more than permissive, and the procedure for forming a district was as follows:

Any contiguous territory having at least 300 inhabitants became eligible for a District, providing that 5 percent of the voters petitioned the respective county judge to submit the question of organizing the proposed District to the voters. After fixing the boundaries and holding a public hearing, the question was submitted to the legal voters of the territory involved. If the majority of the votes cast were in favor of the District, the election was conclusive and the District constituted a body corporate and politic, of which all courts were required to take judicial notice. The affairs of the District were governed by a Board of five Trustees, who were appointed for a 4-year term by the county judge. The financing of the District's operations was obtained from a general property tax, not exceeding the rate of 0.05 percent of assessed property evaluation in the District. In general, the District was empowered to abate mosquitoes, flies and other insects within the territory, subject only to the higher authority of other municipal and public agencies. The only legal liaison that existed between the Districts and the State was the requirement of submitting an annual report of activities to the Illinois Department of Public Health.

This law was preserved in its original form until 1943 at which time the rate of taxation was changed from 0.05 percent to 0.025 percent of assessed property evaluation in the districts. At this time property evaluation was increased, and the actual amount of tax revenue remained about the same.

In 1953 an attempt was made to amend the law in order to provide procedures for withdrawal of specific areas. This law did not pass due to the adjournment of the 1953 Assembly. However, when the Assembly met in 1955, the law was amended to include these procedures.

These new provisions were applicable only to counties of less than 100,000 population, and such withdrawals were subject to the approval of the State Department of Public Health and of the Illinois State Natural History Survey.

In 1957 a bill was introduced in the State Legislature to amend the existing law so as to provide trustees of mosquito abatement districts on an electoral rather than on an appointive basis, but this was not adopted.

As of this date a total of 17 mosquito abatement districts have been organized, the majority of which are located in the northern part of the state. Although there are about 52 species of mosquito in Illinois, *Aedes vexans* appears to be the most

abundant species in all but two of the districts. Only in Dupo and Franklin counties is *A. sollicitans* the more common.

The 17 districts cover an area equivalent to 1.67 percent of the State's territory and serve directly 16.7 percent of its population. Nine of the districts have been organized during the last 10 years, and they in turn cover 77 percent of the total area served by all 17 districts.

These ratios reflect the geographical location of the districts and the growing importance of mosquito control in Illinois. It is noteworthy that the larger districts are located in the County of Cook, where they cover approximately 78 percent of the territory and serve directly only 28 percent of its population. Revenue-wise, the mosquito abatement districts in Cook County collect taxes on one-third of the total assessed property evaluation. The remaining two-thirds of assessed property evaluation, which are not taxed for mosquito abatement purposes, lie within the corporate limits of the City of Chicago and Leydon Township and represent 22 percent of the Cook County area and 72 percent of its population.

The bulk of the recent growth of mosquito control activities has been centered in the Chicago metropolitan area, where a great exodus of population into the suburbs has occurred and leisure time expressed in outdoor recreational activities has increased steadily. Since suburban living and outdoor recreational activities are most enjoyable during the spring, summer and fall seasons, they are dependent to a great extent upon a mosquito-free environment. To obtain such an environment, there is a clear need for additional control measures. In view of the many different sources involved outside the areas affected, changes in the abatement laws may also be required.

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A NIB-POINT MICROLOOP AND ITS CALIBRATION[1]

JACK COLVARD JONES[2] AND A. S. PERRY[3]

In certain types of physiological and toxicological research on arthropods *round* microloops are used in making topical applications of small quantities (0.1 to 0.8 microliters) of insecticides or other substances in suitable solvents. The principal disadvantage to a round microloop is the difficulty in placing the drop with precision on a selected area of a small organism. This note describes a simple modification of the microloop which overcomes this difficulty. Additional information is given on the calibration of the microloop, using three different analytical methods. A comparison is made between the accuracy of the loop with that of pipettes and syringes by radioassay.

CONSTRUCTION OF NIB-POINT MICROLOOP. A circle of 28 gauge (0.0126″) platinum-iridium wire (90:10) is formed with jeweler's tools by winding onto a rod of appropriate dimensions (*e.g.*, 1 mm diameter). When the ring has been formed and its ends forged, it is joined to a platinum handle wire after making it white hot with a jeweler's torch. A rod of 0.125″ hard aluminum ("Dural") is milled with a slitting saw to give a tapering slot of 0.020″. The handle wire is inserted into the slot and a milled nylon ring can then be used to form a split collet grip. With jeweler's pliers the circular loop is bent freehand into the shape of a triangle and the apex of this is carefully filed open with a jeweler's saw (Figure 1).

METHODS OF CALIBRATION. The three methods used for calibrating the nib-point microloop were (1) spectrophotometric, using either Sudan III or Du Pont Oil Red in benzene; (2) colorimetric, using 1.0 percent *p, p'*–DDT (Schechter–Haller technique, 1945[1]); and (3) radioassay, using 1.0 percent *p, p'*–DDT–C^{14} (one loopful applied to filter paper disc 2.97 cm^2), activity being measured in a Q–gas flow counter. As shown in table 1 these three methods give essentially comparable data, variation being somewhat greater with the dye technique.

The data in table 2 show that the accuracy of the microloop is approximately the

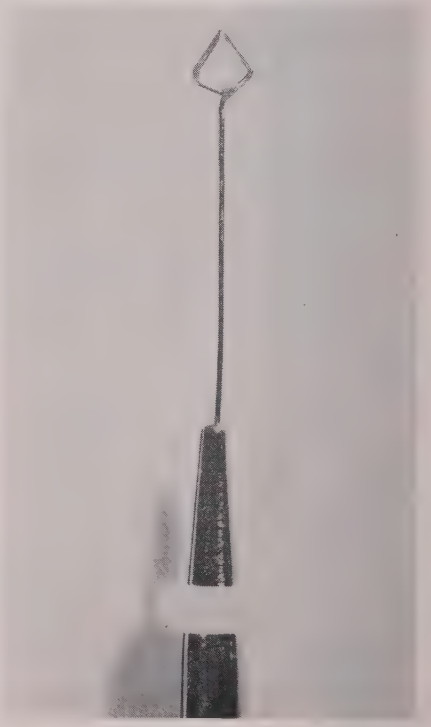

FIGURE 1—Nib-point microloop showing details.

[1] Scientific Article No. A707, Contribution No. 2936 of the Maryland Agricultural Experiment Station, Department of Entomology.

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TABLE 1—Comparison of spectrophotometric, colorimetric, and radioassay techniques of calibration of the same nib-point microloop

Method	No. tests	Mean volume in microliters	Standard deviation	Coefficient of variation
Spectrophotometric [1]	10	0.877	0.103	11.80
Colorimetric [2]	4	0.910	0.045	4.97
Radioassay [3]	10	0.833	0.053	6.45

[1] 1.88 percent Du Pont oil red dye in re-distilled benzene. 1 loopful placed on adult housefly. Housefly placed in 5 ml. benzene.

[2] 1.0 percent *p, p'*–DDT (m.p. 107–108° C). 1 microloop placed on each of 5 houseflies. Schechter-Haller colorimetric analysis performed.

[3] 1.0 percent *p, p'*–DDT–C [14] (m.p. 107.5–108° C). 1 microloop applied to filter paper disc.

TABLE 2—Comparison of microloop, microsyringe and micropipette using radioassay [1]

Instrument	Average c.p.m.	Average volume in microliters [2]	Standard deviation	Coefficient of variation
Microloop	682	0.491	0.037	7.6
Microsyringe	930	0.775	0.062	8.0
1 μl. pipette	1200	1.000	0.042	4.2

[1] Data based on 10 replicates per test instrument. Single drops were delivered to 3 sq. cm. filter paper discs and radioactivity was measured in a Q-gas flow counter.

[2] The volumes of microloops and microsyringes are based on standard volume of the 1 μl. pipette reference.

same as that obtained with either microsyringe or a standard micropipette.

To prevent gross errors in pick-up it is absolutely essential to dip the microloop perpendicularly into solvents. Deliveries should be made quickly and the tip of the nib must be placed perpendicularly on the desired application site.

References

1. Schechter, M., Soloway, H. D., Hayes, R., and Haller, H. 1945. Ind. Eng. Chem. Anal. Ed. 17, 704.

ILLINOIS MOSQUITO CONTROL ASSOCIATION

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OPERATIONAL AND SCIENTIFIC NOTES

PUBLIC HEALTH LABORATORY SERVICE, Malaria Reference Laboratory, Horton Hospital, Epsom, Surrey, Director: Sir Gordon Covell, C.I.E., M.D.; Asst. Director: P. G. Shute, M.B.E., F.R.E.S.

17th November, 1958

(To) the Editor, *Mosquito News*
Dear Sir,

I am interested in the question raised by Mr. J. D. Mabbett on page 259 of your September issue. I wonder if it has any comparison with a war time problem I had to deal with in London. As I think you know, the official opinion was that the London Underground Railways should not be used as air raid shelters because of the risk of epidemics. However, when the "blitz" started in earnest in 1940, Londoners did seek these shelters and very soon it was realized that they would have to be made available both by day and by night. Within a few weeks numerous complaints were made by people being badly bitten by insects. On investigation I was most surprised to find that mosquitoes gorged with blood were numerous at various stations of the system. After many days of searching for the breeding grounds without success, I happened to say to one of the engineering staff "There must be some stagnant (still) water about somewhere." Casually he remarked "Well there is some in the 'inverts' below the station platforms." These inverts are entered through a manhole at each end of the platform, the cables are there and the seepings from condensation cause a few inches of water to collect at the bottom of the "inverts." This water was swarming with mosquito larvae and for the remainder of the war I had five men continuously at work, three by day and two by night, treating these many miles of inverts with larvicides.

For what it is worth, here is my explanation. The species of mosquito involved *(Culex molestus)*, being autogenous, had many years previously got into the underground and had been able to maintain themselves without being observed and without being a pest. Then, when thousands of people slept in make-shift beds on the platforms, blood meals were provided for the mosquitoes with the result that their numbers greatly increased. Conditions were so bad at one stage that it seemed possible that the dwellers would be driven out. Indeed had not active measures been taken I believe this may well have happened.

It was a unique sight to see, day after day, dozens of people queuing at a first aid station one hundred yards below ground level to have their mosquito bites attended to.

Here we had a beautiful example of an autogenous species of mosquito managing to exist for many years without recourse to blood meals. Then, quite suddenly, man invades the insects domain and as the result of unlimited blood meals it increases its numbers enormously.

May it not be that the so-called *Culex fatigans* in the septic tanks is autogenous? If so, it may offer an explanation to Mr. Mabbett's problem.

Yours sincerely,
P. G. SHUTE

UTAH MOSQUITO ABATEMENT ASSOCIATION

Sixty per cent of the people in the state of Utah are now living within the boundaries of organized mosquito abatement districts.

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		Salt Lake City, Utah

Proceedings of Annual Meetings for Sale.

NEWS AND NOTES

AUSTIN W. MORRILL, Jr.

A Navy Captain Who Came Out to California to Retire (and we refrain from comment on *that,* you Florida members) recently told us that the most remarkable job of mosquito control that he has ever encountered in all his Navy travels, is that done at Virginia Beach, Virginia. Commenting on the efficiency of the control crews and their systematic appearance during the season, he remarked how once that region had been all but uninhabitable during certain parts of the day and year. Take a Bow, Rollie Dorer & Cohorts! !

Incidentally, VMCA's *Skeeter* announces February 24 and Suffolk, Virginia, as the time and place of the 1959 Virginia meetings and we certainly hope that many of you got to them, for they are always well worth a trip. Rollie says he'll send us a copy of the program and we will put it in this space (which is being written *before* the meeting date) if he meets our deadline. This is the Twelfth Annual Meeting for the Virginia Association and the fifteenth anniversary for *Skeeter.* Another distinction which should not go un-noted is that VMCA's exhibit was the AMCA exhibit at the meetings of the Entomological Society of America, held in Salt Lake City in December, and the display elicited lots and lots of admiring comment.

The CMCA Meetings Were Held at Monterey, California on the 2nd, 3rd and 4th of February, this year and comprised two principal sections of consideration. On the first day and half of the second, various papers and symposia covered problems of administration and operation, including purchasing, insurance and public education. The remainder of the sessions covered inter-agency coöperation, insect population surveys, gnat research programs, toxicology of new insecticides and resistance to old ones. *Meaty.*

Dr. William E. Bickley of Maryland arranged a "Dutch Mixer" during the annual meeting of the Eastern Branch of the Entomological Society of America, which was held in Baltimore at Thanksgiving time. With the help of Mr. Vernon Conant, Director of our North Atlantic Region, he rounded up some sixty members and guests. Bick says there were no speeches, except that everyone present was urged to make the trip to Salt Lake City in April. At the meeting of the Eastern Branch, Manley Jobbins discussed at length the position of *Culiseta melanura* in New Jersey, for there seems to be considerable circumstantial evidence that this species is a vector of eastern equine encephalitis. Encephalitis is, of course, becoming of increasing concern to entomologists, who are probing the question as to which mosquito is the vector. The New Jersey people believe that *melanura* is a species which should be watched, especially because of its possible importance in maintaining the virus in birds. Dr. R. C. Wallis reported on a rather extensive survey of Connecticut for this species. He concluded that insufficient information is available to consider *melanura* the principal vector in Connecticut but added that much work has been and is being done in attempting to isolate the virus from adult female mosquitoes there.

Dr. Fred Bishopp Sends Us a Clipping from the Ft. Myers (Florida) *News-Press* for November 13, 1958, to show that cattlemen, too, are interested in mosquito control. The clipping described at length a meeting of cattlemen from all over the southeastern states and gave prominence to a talk given the convention by Bob Bartnett, President of the Florida Anti-Mosquito Association. "Animals that are being attacked by mosquitoes cannot possibly gain the weight that undisturbed animals put on," Bob told them. He went on to point out the relationship between mosquitoes and diseases and to explain the relationship between cattlemen and mosquito control districts. From the tone of the clipping, he impressed them with both these basic principles.

Dr. Fred's Letter was sent from Nassau, Bahamas, and said that he and Mrs. Bishopp had attended the meeting of the American Association of Tropical Medicine and Hygiene and were touring Florida in search of a place to pass the winters amid a little less snow than they have in Silver Spring, Maryland. Good luck! We'll hope to hear all about your further travels at Salt Lake City, Fred!

Dr. Melvin E. Griffith, Chief Malaria Control Advisor to Thailand has been helping out in Laos, too, where ICA had no program. All this will now be changed, however, with the arrival there of Dr. Maynard S. Johnson, another AMCA'er who has been until now the Army's civilian entomologist in Japan. Maynard and his wife left the United States on the 24th of January for Vientiane, the capital of Laos, for a four-day Thailand-Laos malaria conference beginning the 2nd of February. This is to be the kick-off of ICA's malaria eradication program. En route, the Johnsons went by Tokyo to clear the things off his desk, which he didn't have time to even put away when he was "recruited" by Don Johnson, awhile back! Well, it's all in the family, Don. Good luck, Maynard!

(Maynard's new address, by the bye, is: USOM Laos, Box L, Navy No. 150 % FPO San Francisco, California)

EARL MORTENSON SENDS US A PARAGRAPH OF INTEREST ABOUT THE FORMATION OF A NEW MOSQUITO ABATEMENT DISTRICT IN FRESNO COUNTY, CALIFORNIA. This has been formed in the western portion of the county and is officially known as the Fresno Westside Mosquito Abatement District. It will comprise 1,325 square miles of area with approximately 800 square miles in irrigated agriculture and more coming. Earl points out that the Board of Trustees is now (or was as of the middle of January) considering applicants for the position of Manager-Entomologist. The salary range will be from $600 to $750 per month, depending on the training, experience and personal qualifications of the applicant, and application may be made to Mr. Roy H. Howard, President of the Board of Trustees, Fresno Westside M.A.D., Box 186, Dos Palos, California. The successful applicant will be handed the knowledge that resistance to parathion is looming in that area, that irrigation and population are zooming and that he should not take Equanil any oftener than once in three hours.

YE OLDE HARRY (STAGE, that is) sent us the proceedings of a conference on mosquito control held at Pullman, Washington, on November 5, 1958, just too late for our December deadline, alas. The conference surveyed the progress of mosquito abatement in the Columbia Basin area and the advancement of knowledge on mosquito species involvement. They heard a report of the activities of entomologists under the direction of our Harry and discussed insecticide resistance (naturally) before giving consideration to the establishment of a permanent mosquito control association and inviting the expression of opinion as to the desirability of establishing a spring short-course in mosquito control.

YOU MAY REMEMBER OUR MENTIONING GEORGE BURTON'S NEW WORK ON FILARIASIS IN INDIA and the distances involved in his travels within that monumental and populous nation. Well, if you have ever wondered idly how come the ubiquitous "cocoa mat" in front of people's doors happens so often to be stamped "Made in India," George has found out a lot about that for you. Those fibres *are* cocoanut husk and they *do* come from India. They are grown down in Kerala and part of the preparation process involves letting the husks lie in tanks of water and rot until the fibres are loosened. All this is, of course, just fine for mosquitoes and also produces a lagoon suitable to growth of *Pistia,* to the roots of which *Mansonia* makes its customary attachment. All this is in the light of the developing fact that *Mansonia* accounts for about 15 percent of the filariasis and *Culex fatigans (quinquefasciatus* to you and you and you) for 85 percent, tying it up between them pretty well. The people who run the rotting tanks don't want them sprayed, needless to add. They like mosquitoes.

BRIAN HOCKING APPEARS IN THE NEWS EVERY NOW AND THEN AND THE LEAFLET *Scan* is the latest to write up his long and productive studies on the flight of insects. The Shell Co.'s informative little sheet digests an article Dr. Hocking wrote for the *Scientific American* and we advise you to look *that* up in your library, for it is mighty interesting. Brian is quoted as summarizing, "Insect flight is a complex and controlled action which has served insects well, as is testified by their survival in this man-infested world."

FRANCISCO BAISAS IS THE AUTHOR OF A THOROUGHGOING AND FACT-PACKED article on filariasis in the Philippines, which originally appeared in the Philippine *Journal of Science* in 1957, but has just reached us in the form of a reprint published in 1958. Part of his classic series of *Notes on Philippine Mosquitoes* (XIX), the present article is entitled, *The Mosquito Problem in the Control of Filariasis in Sorsogon Province* (Southeast Luzon). In the study reported, *Culex fatigans* was found for the first time in nature with infective third-stage microfilariae, and, disturbingly, they were found in mosquitoes resting imperturbably on walls where traces of DDT were readily visible. Similar resistance was found in three other of the principal vector species.

TOM MILLER (JR.) SENDS US HIS FIRST ANNUAL REPORT OF THE LEE COUNTY (FLORIDA) MOSQUITO CONTROL DISTRICT which was born on the 21st of January, 1958, of a consolidation of three former districts, with a legacy of accomplishments, equipment . . . and problems. The former component districts had comprised less than 8 percent of the County (the more densely habitated areas) whereas now the District contains 98 percent of the County, and a lot of untaxable but highly mosquito-infested areas, at that. Fortunately, this year was a light mosquito year and they were able largely to concentrate on basic environmental work. much of it in line with Dr. Provost's recent findings; but here is the rub. The citizenry took the natural lightening of the population to be the result solely of the new District's efforts and Tom fears (as we know too well, with reason) that *next* year they may not at all understand why the mosquitoes are still around in some numbers. Well, good luck next year!

GEORGE THOMPSON'S ANNUAL REPORT FROM JEFFERSON COUNTY (TEXAS) details a valiant (and successful) fight against irregularities in the environment in the form of alternate droughts and floods, which is both consoling and heartening to those of us faced with similar problems. Two points which seem of particular interest are George's use of chemical non-hormone herbicides and the use of airplanes, not only for insecticide dispersal but also for reconnaissance and indoctrination. Both were very effective, in George's view; he points out that the aerial reconnaissance by ground personnel gives them a better view of their work both psychologically and physically.

CHET ROBINSON REPORTS THAT ALAMEDA COUNTY'S MOSQUITO ABATEMENT DISTRICT partici-

pated in a County Government on Display exhibit at which the District's color pamphlet entitled, *Mosquitoes Are Unnecessary,* was handed out to the tune of two thousand copies. The exhibit contained also photos of operations and two tanks of water, one with mosquito larvae and one with mosquito fish. The pamphlet emphasizes individual responsibility and ought to be a very valuable booster both of the public rapport and public participation.

Ted Raley's Words of Wisdom to Many Interested Members have no doubt been duly noted by many of you but can well bear repeating here. Ted points out that each of us can fulfill a vital function in AMCA by participating in two of its least time-consuming activities. That is, you can participate without consuming any more time than it takes to write a single sentence. First is the Good Neighbor Club, which you can join by merely writing one little line and your name on a check. This enables you not only to strengthen AMCA and *Mosquito News* but individually and effectively to participate in the United States of America's Technical Assistance program. The second activity is to encourage the suppliers you buy from to put ads in *Mosquito News.* This will help both them and you . . . and thus, *us.*

Travis McNeel Returned to Talullah (Louisiana) for the Holidays and thus signalled the end of his tour in Mexico. He didn't say if he was going to stay in this country now for a change, after his rapid-fire transition from the Philippines to Mexico, or if he, too, is going to be a permanent AMCA Globetrotter. We can tell him one thing, that mosquito-borne virus, *Wandervogelitis,* is durn hard to eradicate.

If the Lieutenant May be Allowed to Present His Compliments to His General (this isn't *done,* militarily speaking), "News and Notes" would like to applaud the editorial on the Defense of English, or Gobbledegook Deplored. We have been as guilty as anyone, we fear, in straining the language past its normal limits of elasticity in our labored efforts to be Light and Witty. Sometimes what we write seems rather different in cold print, (as in our remarks about Dr. Knipe's article in the last issue, which sounds rather contentious as we read it over, when we meant merely to be chatty). But it is certainly high time to View with Alarm the spectacular displays of semantic virtuosity which nowadays construct elaborate and meaningless circumlocutions where perfectly good and meaningful words already exist. Incidentally, Ed, this business of *attrahent:* it may interest you to know (as if you didn't) that the old Bureau of Entomology made a valiant effort to promulgate the word and did get wide acknowledgment that it was *correct,* all right, back in the 30's, but it was just that nobody wanted to use it. Couldn't seem to make it sound right when it was read out loud.

Another Thing Ted Raley Told Us in His Letter was that Dr. Osmond P. Breland has replaced Dr. Micks as Director for the Southwest Central Region. Don is in Geneva, according to Ted, who says that so far he hasn't heard one word against Alaska from our biggest glacier-free state. But just wait until we start reading about all the doings of the AMCA and wake up to the fact that it's the *Alaska* Mosquito Control Association they mean!

That Takes Care of Our Newest State, We Think. We Will Now Lead Off Our Who's Who in AMCA With Two Members from Our *NEXT* State.

Pat Nakagawa, who was mentioned in the December issue for his notable work on the Membership Committee, is the Chief of the Bureau of Mosquito Control in the Division of Sanitation of the Department of Health of Hawaii. Pat was born there in 1920 and received his B.S. there in 1942, after which he went to the University of Minnesota (which is about as far as he *could* go, climatically, we guess) for his M.S. He served with the famed, "most decorated" 442nd Infantry during World War II in Italy and France and, after receiving his M.S., returned to Hawaii on the Oriental Fruit Fly Investigations. He was entomologist for the U. S. Army, Pacific, from 1951 to 1955, when the Air Force snatched him away for three years, as civilian entomologist. A year ago he was tapped for his present position when Dr. Hu joined the Naval Medical Research Unit No. 2, of which more later. Pat's hobby, beside being a top-flight and modest golfer, is wood-working and (*we* think, from the results) gardening . . . . Pat says you don't garden in Hawaii, everything just grows. He is a member of the Entomological Society of America, the Society of the Sigma Xi, the Hawaii Entomological Society and the Hawaii Public Health Association, as well as of the AMCA.

Dr. Stephen M. K. Hu, whom we mentioned above, was born in Honolulu in 1903 and spent his early years, no doubt, congratulating himself on his perspicacity. This same perspicacity led him, however, to choose mosquitoes and their role in disease transmission as a life work, and this led him to Cornell University where he took his B.S. in 1928 and his M.S. in 1929. In 1931, switching to Johns Hopkins for his Sc.D., his thesis was on the subject of *Mosquito Transmission of Dog Filariasis.* Field studies with the Rockefeller Malaria Research Stations in Florida and the Philippines and with the Henry Lester Institute in Shanghai, with UNRRA and the Army Advisory Group, led up to his appointment to the Bureau of Mosquito Control of the Hawaiian Department of Health, which Bureau he headed for ten years. Dr. Hu lists among his honors the fact that he studied under such able and renowned men as Professor Robert Matheson, Professor Francis Post,

Dr. Mark Boyd and Dr. Paul Russell and we imagine that they consider it among their honors to have had so distinguished a student and colleague. He is now with the U. S. Naval Medical Research Unit No. 2, APO 63, San Francisco, and besides being a member of the American Society of Tropical Medicine and Hygiene, the Hawaiian Entomological Society, the Hawaiian Academy of Science and the Society of the Sigma Xi, is also a member of the Lions Club, Sinim Lodge and the Islam Temple and finds time to go in for the contemplative hobbies of swimming, shell collecting, fishing and occasionally, exchanging fins and goggles for boot, to go hiking. Who said that these Tropical Paradises make people lazy?

HAROLD TRAPIDO, although he was born in Newark, New Jersey (in 1916), is another example of how the tropics sap one's energies. He got off to a running northern start, of course, having taken his undergraduate work at Cornell and enough of his graduate so that he could achieve his Ph.D. on a three day pass from the Army in the early part of the War! His careful and effective work as Lieutenant in charge of mosquito control at Camp Davis was thoroughly, though rather too quietly, appreciated by his military superiors and led in 1944 to a course in tropical and military medicine at Walter Reed Army Medical Center and assignment to the Gorgas Memorial Laboratory in Panama. He arrived there for 120 days temporary duty and did not leave until 1956, some 4370 days later. By then he had managed to get out of the Army, anyway. Well, he did have occasional leaves of absence, such as being consultant on the *Anopheles labranchiae* eradication program in Sardinia. He worked on the bionomics and behavior of *A. albimanus* in Panama, as he says, quite happily, until yellow fever suddenly showed up and from 1948 on he gradually became involved in the study of forest mosquito fauna in relation to sylvan (*not arbor*, ED) yellow fever. In 1956, as mentioned previously in N. and N., he joined the Rockefeller Foundation to go to the Virus Research Centre in Poona, India. In addition to the fascinating investigations on the Kyasanur Forest Disease, of which Bill Reeves brought us word in December, Harold has also been involved in studies on the mosquitoes associated with the transmission of the viruses of the Japanese B encephalitis—West Nile complex. "An immediate problem here," he writes, "is that while viruses have repeatedly been isolated from what has been called in India *Culex 'vishnui'*, it now appears that at least four species are passing under that name and the females cannot as yet be told apart." Seems to us that Vishnu was famous for having had some nine reincarnations. Wasn't there something about telling them apart by the number of arms, Harold?

THE BULLETIN OF THE LOUISIANA MOSQUITO CONTROL ASSOCIATION comes to us from the desk of Ted Raley just in time to make this issue and to make a good start, too, for mosquito control in 1959. Things are really humming down there on the Old Bayou, where the first annual meeting was scheduled for the L.S.U. campus on the 24th of January. In the November elections, the voters ratified a Constitutional Amendment which authorized the "police juries" to set up mosquito control districts supported by *ad valorem* taxes. The vote on this amendment was quite lop-sided, as the Bulletin notes, some parishes going heavily for while others went almost as strongly against and some stayed mighty near the middle, though approving; so the battle is just begun. However, the Plaquemines Parish Police Jury (where the vote was in favor almost 17 to 1) led off by paying sustaining membership dues of one thousand dollars to the Association. For the benefit of the uninitiated, a Parish is a County, sort of, and a Po-lice Jury is the County Commission. The Orleans Parish voted official endorsement of the scientific program of the LMCA, devoted to survey and pilot experiments in control techniques for Louisiana areas, and in keeping with its scientific interest, the LMCA Bulletin devotes considerable space to discussions of the work of other mosquito control associations and workers. AMCA'er E. B. JOHNSON, the Public Health Entomologist of the Louisiana State Department of Health, and a member of the Louisiana Association's Technical Advisory Board, was headlined in the Who's Who section of the issue of the Bulletin Ted Raley sent us. Bon voyage, LMCA!

GEORGE THOMPSON OF THE JEFFERSON COUNTY (TEXAS) MOSQUITO CONTROL DISTRICT has been promising further information on his use of BHC dusts in adulticiding and we have just received his rundown on last season's work. This business of using dusts has, of course, been receiving more and more attention, as we have previously noted here. Following its very successful use in overseas military areas and occasional reports on it from this country, LCDR Bob Du Chanois ran some extensive comparative tests and reported on the dusts quite favorably. Meanwhile George Thompson's extensive use was arousing more and more interest, and we are delighted to present a summary of it for those who have been asking.

George's trucks are all one-man operated, essentially half-ton pickups with heavy duty springs and turbine duster units mounted on the body with their own power from 8 HP, 1 cylinder engines. Large hoppers are used, which hold three 50-lb. sacks, and George says he is shooting for a hopper which will hold four or five sacks. He says, incidentally, that though it may seem odd, the flat slope is better than the steep one on a large hopper. He didn't say if he used an aerator unit to fluidize the dust and it would be interesting to try it, if he hasn't. Controls of the unit are extended through the cab into the truck and, except for a roving mechanic, one man per truck is all that is needed.

Trucks cruise at a speed between 10 and 15 mph and the dosage is two sacks of 5 percent BHC dust per three miles. This gives a rate of just under 0.1 lb. per acre (approximately) and by carrying 24 to 26 of the 50-lb. sacks, the trucks can carry on a five hour operation from sunset to about 11 or 12 p.m. George says he uses the 5 percent dust because it is actually cheaper than the 3 percent.

In 1958, the costs of operation were about $5.90 per cwt, for the dust, $1.75 an hour for labor, or a total of about $3,932.78 for 8,920 miles. With a swath width of 200 feet, they reach about 25 acres per linear mile, and this figures to an average of $0.113 per acre, and includes everything. George says he had lower costs on automatic transmissions than gear shift trucks, too! Thanks for the interesting info, George!

The Northeastern Mosquito Control Association held its fifth annual meeting on February 19 and 20, 1959 at the Somerset Hotel in Boston, Massachusetts. The program included papers on mosquito control legislation, granular insecticides, eastern equine encephalomyelitis, water resources, and current field problems in mosquito control. Dr. William Jellison, U.S.P.H.S., discussed arthropod-borne diseases of animals.

The following officers were elected for 1959–1960: President, Hugo Jamnback; Vice President, Robert Armstrong; Second Vice President, William Maynard; and Executive Board Member for three years, Edward Duda.

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REVIEWS AND ABSTRACTS

BITING BEHAVIOUR OF MATED AND UNMATED FEMALES OF AN AFRICAN STRAIN OF AEDES AEGYPTI. By M. M. J. Lavoipierre. Nature 181 (4626):1781–1782. 1958. Studies were conducted on female mosquitoes of the African strain of *Aedes aegypti* which had been maintained in the Department of Entomology and Parasitology, Liverpool School of Tropical Medicine since 1938. The author points out that although the investigations reported are not directly concerned with ovarian development hormones or ovulation hormones, they might conceivably throw some light on the gonadotropic activity in mosquitoes.

The means taken to assure controlled rearing and test methods are described.

The second day after emergence, mosquitoes were allowed to bite a human, and were thereafter offered blood daily. The percentage of fertilized females feeding decreased sharply during the first 4 days (from approximately 80 percent to 6 percent) with the onset of oviposition. Unfertilized females maintained a high biting level (for the most part above 40 percent) with oviposition level low. Tests through the 11th day showed that this relation continued through several cycles in the fertilized group, with biting decreasing as oviposition began.

Dissection of a control group of mated females showed that biting decreased after oocytes reached the third stage, and that when the females began to feed at the late third or fourth stage of oocyte development, they took smaller meals.

The author discusses the probable explanation for the marked reduction in biting in fertilized females as oocyte development progressed. He points out that pressure is not a factor, since there is a high percentage of feeding by unfertilized mosquitoes, with retained and pigmented eggs and extensive fat body.

He hesitates to speculate with the material at hand in this preliminary paper, but is tempted to suggest that, "the production of increasing amounts of ovulation hormone in the gravid fertilized female inhibits the mechanisms by which the mosquito is induced to feed and that the inhibitory effect is very rapidly removed following oviposition."

Survival rates differed when fertilized and unfertilized mosquitoes were offered daily blood meals. The former dropped from the original 100 percent to almost zero on about the 118th day, whereas the latter survived until approximately day 87. It is likely that the difference was due to factors associated with ova retention rather than with feeding, since two groups of unfertilized females were compared, one fed daily, the other, every 10 days; and the survival rates of the two were almost identical.

It would have been better had the actual number of tested mosquitoes been given, rather than unspecified numbers with percentages. The paper is one worth reading.—H. L. T. D.

PRIMEIRAS PROVAS DE DETERMINAÇÃO DA SUSCEPTIBILIDADE DE ANOFELINOS BRASILEIROS AOS INSECTICIDAS. II—*ANOPHELES (NYSSORHYNCHUS) DARLINGI,* EM ENGE NHEIRO DOLABELA (ESTADO DE MINAS GERAIS). By Rachou, R. G. Moura Lima, M., Paulini, E., and Memoria, J. M. Pompeu. Rev. Bras. Malariol. D. Trop. 9(3): 351–355. 1957. The susceptibility of *Anopheles (Nyssorhynchus) darlingi* adults to DDT in Engenheiro Dolabela, State of Minas Gerais, Brazil, was tested using Busvine and Nash's method. The mosquitoes were collected with human and animal (horse) bait. The corrected mortalities (Abbott's formula) for the first (human bait) set of experiments are:

DDT concentration:	2.00%	1.00%	0.50%
% of mortality:	97.7	69.3	34.1

The results obtained (corrected) for the second set (animal bait) were:

DDT concentrations:	1.00%	0.50%	0.25%
% of mortality:	93.1	62.3	31.0

The LC_{50} obtained by interpolation for the mosquitoes captured with human bait was 0.71, whereas that of those collected with animal bait was 0.37. The LC_{50} were also calculated by the probit method, following Finney (1952): 0.38 ± 0.02 and 0.70 ± 0.03 for mosquitoes respectively captured with animal and human bait. In the last case we considered only the tests performed in the same days with the concentrations of 0.50, 1.00 and 2.00% (heterogeneity chi square not statistically significant). The difference in susceptibility of the two batches of mosquitoes may originate either from the difference of quality and quantity of the blood meals (human-animal) or from the appearance of resistance. All houses of the village have been treated with DDT once, twice, or three times a year since 1946, thus the anthropophylic strain might have been under DDT pressure for 10 consecutive years (in a total of 22 applications of DDT), whereas the zoophylic strain had less chance to suffer from the insecticide. Work to clear up these hypotheses is in progress.—Authors' summary.

THE MOSQUITOES OF MINNESOTA (DIPTERA: CULICIDAE: CULICINAE). By A. Ralph Barr. Univ. Minn. Agric. Exper. Sta. Tech. Bull. 228. 154 pp., 42 plates, 132 figs. 357 refs. 1958. This is a new publication on the mosquitoes of the State rather than a revision of the bulletin written by this reviewer in 1937. Nine genera and 47 species are included in the work. Of these, 26 are *Aedes,* 5 *Anopheles,* 6 *Culex,* 4 *Culiseta,* 2 *Psorophora,* and one each of *Mansonia, Orthopodomyia, Uranotaenia,* and *Wyeomyia.*

Descriptions and keys are given for adult females, male terminalia and larvae. Separate keys are presented for adult females of the *Aedes*

communis and *Aedes stimulans* groups. The illustrations by Sylvia Barr, the author's wife, are excellent. Information on the biology of each species is up-to-date and quite comprehensive. Locality records are not listed in the remarks on geographical distribution. The bulletin has been edited with care and the information is well-documented. This is an outstanding work which students of mosquitoes should obtain while it is available.—William B. Owen, University of Wyoming.

Annual Report of the Malaria Division, Health Department, Trinidad and Tobago, 1957. The Malaria Division, Port of Spain, Trinidad, West Indies. 71 pp. "There was no epidemic of malaria in any part of the Colony during the year." This is from the report's first chapter, Malaria Studies. Other chapters are: Entomological Section; Anopheline Investigations; Malaria Control; Tobago-Malaria Eradication Programme; Anti-*Aedes aegypti* Measures, 1957; and, General. Special Reports appended are: 1. Bromeliad Re-infestation and Residual Malaria in Sangre Grande, Trinidad, T. W. I.; 2. The Effect of Malathion, Diazinon, Dipterex, and Parathion Formulations on 4th Instar Larvae of DDT-resistant *Aedes aegypti* in Trinidad, T. W. I.; 3. Malaria Transmission and the *A. bellator-A. aquasalis* Population Complex in Fishing Pond, Trinidad, T. W. I.; 4. Resistance of Bed Bugs (*C. hemipterus*) to DDT.

The mortality for each year from 1940 to 1947 (inc.) is listed, with 348 deaths reported for 1940, with a gradual decline to 20 and 6 for 1956 and 1957, respectively. It is pointed out that only one blood smear in 1956 and one in 1957 were taken to support the cause of death. The remaining 24 were unsupported by parasitological findings. Morbidity reports list 20,691 malaria cases in 1940, with a sharp drop in 1945—attributed to the formation of the Malaria Division in 1943—until 1957 when only 452 cases appeared. Of 2,402 slides made and examined for parasites, 433 (18.03%) were positive. Of these, 364 (84.07%) were *Plasmodium falciparum* infections, 67 (15.47%) *P. vivax*, and 2 (0.4%) *P. malariae*.

The report of the Entomologist, T. A. Omardeen, includes a summary of laboratory investigations. There were identified more than 112,500 anopheline adults and 6,900 larvae. *Sabathes cyaneus* larvae from a treehole were among specimens submitted by the *Aedes aegypti* recheck team. Totals of 997 *A. bellator* and 929 *A. aquasalis* adults were dissected and examined for sporozoites and oocysts. All were negative.

Bromeliads, as breeding places for *A. bellator* larvae, were destroyed by copper sulphate sprays and by manual means. Intensive control and survey measures were pursued.

A grand total of 109,701 houses were sprayed in the residual DDT program.

The chapter on anti-*aegypti* measures outlines the problems encountered, particularly treehole and eaves gutter breeding, and discusses dieldrin spraying. We read an optimistic note near the chapter's conclusion—"Provided no serious problems are encountered in the next couple of years, there is every hope that *Aedes aegypti* would soon be completely eradicated from Trinidad and Tobago."

Resistance of *Aedes aegypti* to DDT was observed after the yellow fever epidemic of 1954, and BHC was then used in eradication campaigns. Other insecticides were tested as a precautionary measure. Malathion, diazinon, dipterex, and parathion formulations were tested against 4th instar larvae of DDT resistant *aegypti*. Eighteen concentrations of each insecticide, ranging from 0.001 ppm to 5.0 ppm were used; 1,000 larvae for each concentration. Parathion was most effective, malathion next; but malathion because of its lower toxicity to mammals was chosen as the best for use in the eradication program.

The report is a bulky one, almost a hundred pages, 8½ by 14 inches each, stapled together. It is well-documented, with numerous graphs, charts, tables, and supporting data.

In concluding, we refer to Dr. William Reeves' visit to Trinidad, mentioned in "News and Notes," *Mosquito News*, Dec. 1958, page 332.—H. L. T. D.

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REFERENCES TO LITERATURE OF INTEREST TO MOSQUITO WORKERS AND MALARIOLOGISTS

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